PUBLIC HEALTH ASSESSMENT

Air Addendum

AMOCO-SUGAR CREEK
(a/k/a AMOCO-SUGAR CREEK)
SUGAR CREEK, JACKSON COUNTY, MISSOURI
EPA FACILITY ID: MOD007161425

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LIST OF ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AML	Acute myelogenous leukemia
Amoco	Amoco Oil Company
ATSDR	Agency for Toxic Substances and Disease Registry
CNS	Central Nervous System
CREG	Cancer risk evaluation guide
Conc.	Concentration
EFR	Enhanced fluids recovery
EMEG	Environmental media evaluation guide
EPA	Environmental Protection Agency
IEMEG	Intermediate environmental media evaluation guide
IARC	International Agency for Research on Cancer
J	Estimated concentration
kg	Kilogram
LPG	Liquified petroleum gases

m^3	Cubic meter
Max.	Maximum
MDNR	Missouri Department of Natural Resources
mg	Milligrams
ND	Not detected
NOAEL	No-observed-adverse-effect level
NTP	National Toxicology Program
OVA	Organic vapor analyzer
PCE	Tetrachloroethylene
PID	Photo-ionization detector
ppb	Parts per billion
ppm	Parts per million
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RfC	Reference concentration
RFI	RCRA Facility Investigation
RMEG	Reference dose media evaluation guide
STEL	Short-term exposure limit
TCE	Trichloroethylene
TFE	Total fluids extraction
TLV	Threshold limit value
TPH	Total petroleum hydrocarbons
µg	Microgram
VOCs	Volatile organic compounds

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1. SUMMARY

In June 1998, the Agency for Toxic Substances and Disease Registry (ATSDR) received a petition to conduct a public health assessment of the former Amoco Oil Company petroleum refinery in Sugar Creek, Missouri. Petitioners described the Norledge area, adjacent to the southern boundary of the site, as an area at particular risk for off-site migration of contaminants. Through a series of public health assessments and health consultations, ATSDR evaluated off-site groundwater, soil, soil gas, sediment, surface water, and air data for the Norledge area. This public health assessment focuses specifically on whether Norledge area residents are chronically exposed to benzene and other contaminants in indoor air at levels of potential health concern.

ATSDR evaluated indoor air data collected in June, July, and October 1999 from Norledge area homes and found that a current, completed exposure pathway to indoor air exists for residents who live in this area. However, the chemical levels detected would not be expected to produce adverse health effects in Norledge area residents. Ongoing remedial activities in the Norledge area should result in decreasing contaminant concentrations in groundwater and subsurface soil. Therefore, any potential contribution from these media to indoor air levels should decrease as well.

2. PURPOSE AND HEALTH ISSUES

In June 1998, the Agency for Toxic Substances and Disease Registry (ATSDR) received a petition to conduct a public health assessment of the Amoco Oil Company (Amoco) site in Sugar Creek, Missouri. Petitioners described the Norledge area, adjacent to the southern boundary of the site, as an area at particular risk for off-site migration of contaminants. The Norledge area of Sugar Creek comprises approximately 130 residences.

ATSDR evaluated short-term exposures to indoor air in the Norledge area as part of a November 2000 public health assessment. In that 2000 assessment ATSDR determined that current short-term exposures to indoor air contaminants are not likely to be associated with adverse health effects. But sufficient air data were not available at that time to determine whether Norledge area residents are chronically exposed to elevated levels of benzene in their residences. ATSDR recommended sampling indoor air (24-hour composite samples, several times a week) in the Norledge area to determine whether current, chronic levels of benzene are of public health concern (ATSDR 1999a).

In June 1999, the Environmental Protection Agency (EPA) conducted indoor air sampling (24-hour composite samples) at seven homes in the Norledge area. Each home was sampled every other day for a period of 1 week. In July, three of these homes were re-sampled for an additional week. In October 1999, the EPA responded to an odor complaint and collected additional indoor air samples at one home in the Norledge area. This public health assessment focuses on a review of the June, July, and October 1999 air sampling data reports to determine whether current chronic indoor air exposures are of potential health concern for local residents.

3. BACKGROUND

3.1 Site Description and History

The Amoco Oil Company began petroleum refinery operations in Sugar Creek, Missouri in 1904. Crude oil was brought in by pipeline from several states to produce gasoline, distillate fuels, jet fuels, residual fuels, asphalt, petroleum coke, liquified petroleum gases (LPG), sulfur, and polymers (TriTechnics Corporation 1995). Although petroleum refinery operations ceased in 1982, Amoco has continued to use portions of the site as a light oil petroleum product marketing terminal, a pipeline facility, and an asphalt receiving and processing center (TriTechnics Corporation 1995).

While the refinery was operational the site consisted of numerous processing units and storage tank areas. Leaded gasoline and naphtha were used onsite (EPA 2001b), and numerous spills and leaks occurred throughout the site.

3.2 Land Use

The Amoco site occupies approximately 500 acres on both sides of Sugar Creek (see Figure 1, Appendix A). The Missouri River bounds the site to the north, wooded areas are on the East Bluff and West Bluff, and residential areas are to the south (TriTechnics Corporation 1995). The Norledge area is adjacent to the south side of the site. The Atchison Topeka & Santa Fe and the Missouri Pacific railroad lines run through the northern portion of the site.

3.3 Demographics

According to the 2000 U.S. Census of Population and Housing (Bureau of the Census 2001) the demographic statistics for locations within 1 mile of the Amoco site identified 9,708 persons residing in 4,446 households. Of these, 92.2% were white, 1.4% were black, 0.7% were American Indian and Alaska Native, 0.6% were Asian, 1.0% were Native Hawaiian and Other Pacific Islander, 1.6% were members of other races, and 2.5% were members of two or more races. The Census also identified 927 children 6 years of age or younger and 1,393 adults 65 years of age and older. Please refer to Figure 2, Appendix A, for additional demographic statistics.

3.4 Remediation and Sampling Activities in the Norledge Area

Resource Conservation and Recovery Act (RCRA) regulated operations at the Amoco refinery. When refinery operations ceased, a RCRA Facility Investigation (RFI) identified for investigation potential contamination sources, areas, and characteristics (TriTechnics Corporation 1995). Since submission of the 1995 RFI report the EPA and the Missouri Department of Natural Resources (MDNR) have taken a different approach to completing the RFI process. Due to public concern, the agencies have focused most of their investigation in the off-site plume area. Amoco has since submitted an RFI report focused solely on the off-site plume area. This was done to expedite investigations and to implement cleanup activities in the off-site area. Subsequent investigations will be conducted in a phased manner for the remainder of the site (EPA 2001a).

Groundwater investigations have identified one off-site area of benzene contamination and two off-site areas of free product contamination in the Norledge area (TriTechnics Corporation 1995). Through construction of interceptor drain systems and trenches, in the late 1950s Amoco began efforts to recover free product and in the 1960s to control the migration of hydrocarbons dissolved in groundwater (TriTechnics Corporation 1995). In the 1970s this program expanded and in the 1980s expanded further with the construction and expansion of the Norledge Interceptor Trench Recovery Network. In addition to the interceptor trench, interim measures include enhanced fluid recovery (EFR) and total fluids extraction (TFE) (BP 2002).

On a bi-weekly schedule Amoco conducts EFR on wells in the Norledge area. During the EFR process a vacuum truck is connected to each well to extract fluid and vapors. Free product is collected for recycling, contaminated groundwater is sent to a treatment system, and vapors are treated by activated carbon canisters. To maximize the effectiveness of the process, the locations of the EFR events are adjusted periodically (BP 2003). Since this EFR activity began, levels of contamination have decreased (EPA 2002). EFR has been successful in assisting in the natural attenuation of VOC concentrations in groundwater; benzene concentrations have been decreasing (BP 2003). Monitoring wells located in the Norledge area are monitored and sampled quarterly.

The TFE system is similar to the EFR system in that fluids including groundwater, free product, and soil vapor are removed. Additionally, TFE stimulates the biodegradation of hydrocarbons by introducing oxygen through the subsurface (BP 2002). The TFE system consists of nine horizontal wells. The first two horizontal recovery wells were installed and pilot-tested in late 1999 and seven additional horizontal wells started operations in early 2001. As of April 2002, the TFE system met shutdown criteria and the Confirmation Monitoring Program began (BP 2003). Approximately 87,300 pounds of hydrocarbon were removed during the system's operation, with the greatest mass removal from biodegradation (68,600 of the 87,300 pounds) (BP2003).

The current investigation includes underground pipelines. Starting in the 1970s, Amoco began to replace underground pipelines with above-ground pipelines to reduce the potential for undetected releases (TriTechnics Corporation 1995). (Amoco's active pipelines currently enter the site from the eastern and northern borders.) Two of Amoco's old product pipelines run through the Norledge area – one along Northern Street and one along Carlisle Street. Williams Natural Gas currently owns the pipeline which runs along Northern Street – that line supplies natural gas to the local power plant. The line along Carlisle Street was abandoned in the early 1980s (EPA 2001a). The decommissioned underground lines were flushed with water in 1986B1987. Still, a leaking pipe in a tank dike indicated that some product remained after flushing occurred. EPA requested that Amoco prepare a plan for investigating underground pipelines. As part of future investigations, Amoco will examine the underground pipes and the other subsurface structures (EPA 2001b).

3.5 Response to Odor Concerns in the Norledge Area

EPA and MDNR established standard operating procedures in response to odor concerns in the Norledge area. The preferred first responder to indoor air complaints is the Sugar Creek Fire Department. To collect initial field screening information during odor events, EPA loaned the fire department a combustible gas indicator (CGI) and a photo ionization detector (PID). Recently, EPA transferred ownership of the CGI to the fire department; it is expected that in the near future PID ownership will also be transferred to the fire department (EPA 2002). EPA and MDNR would use the screening information to determine whether additional response and sampling are necessary. As of October 2002, neither EPA nor MDNR have been called upon to follow up on an odor complaint received by the Sugar Creek Fire Department (EPA 2002).

4. DISCUSSION

ATSDR evaluates contaminants detected in environmental media at hazardous waste sites and determines whether an exposure to that contamination has public health significance. ATSDR begins this evaluation by reviewing environmental data to determine whether levels of contaminants are above health-based comparison values. Health-based comparison values are media-specific concentrations of chemicals not likely to result in adverse health effects under default exposure conditions. Refer to Appendix C for further information on health-based comparison values. Once the environmental data have been obtained and evaluated, ATSDR determines whether people were, or continue to be, exposed to the contaminants (see Appendix D). ATSDR determined that a current completed exposure pathway to indoor air exists for people living in homes in the Norledge area, with inhalation as the main route of exposure.

ATSDR evaluated air data collected during two sampling events. Seven homes were included in the June/July 1999 sampling event (see Figure 3, Appendix A, Homes 1 through 7) and one home was included in the October 1999 sampling event (see Figure 3, Appendix A, Home 8).

4.1 June/July 1999 Sampling Events

To help assess chronic exposure levels, in June and July 1999 off-site air samples were collected in the basements of homes located in the Norledge area. Prior to sampling, EPA inspected each basement to ensure there were no other potential sources (ATSDR 1999b). All basements were finished and in good repair (ATSDR 1999b). A few of the homes had attached garages, but they were not used for cars (EPA 1999a).

During the June 1999 sampling event, EPA collected three indoor air samples in each basement of the seven homes. The sample interval was 24 hours, every other day. During the July 1999 sampling event, three of the seven homes were re-tested under the same conditions. Nine outdoor samples were also collected from five of the homes (EPA 1999b). In both indoor and outdoor air samples benzene, acrylonitrile, carbon tetrachloride, chloroform, and methylene chloride levels exceeded health-based comparison values. In addition, 1,2-dichloroethane, tetrachloroethylene, and trichloroethylene exceeded health-based comparison values in indoor air (see Tables 1 and 2, Appendix B).

4.2 October 1999 Sampling Event

On October 14, 1999, a family in the Norledge area reported a strong odor inside their home. That evening, an organic vapor analyzer (OVA) and draeger tubes were used take readings in the basement, in all first floor rooms, and in one second floor bedroom. Because they lack both the specificity and the sensitivity of follow-up analytical techniques, draeger tubes and OVA probes are typically used only for screening purposes. When screening indicates the need for additional (that is, chemical-specific) data, follow-up analytical techniques are used.

Immediately adjacent to the sewer drain in the basement floor was an open cleanout line. A cleanout line is a pipe that bypasses the water trap on a drain pipe, providing plumbers direct access to the sewer lateral when clearing out clogged lines. To avoid confusion, the term "drain," as used in this document, will refer only to an open pipe with a water trap; the adjacent pipe that bypasses the trap will be referred to as the "cleanout line." Because cleanout lines have no water trap to exclude sewer gases – as drains normally do – cleanout lines must always remain capped when they are not being accessed by a plumber. When EPA responded to the odor complaint on October 14, 1999, the cleanout line was open (ATDR 1999c).

On October 14, 1999, an OVA registered total volatile organic compounds (VOCs) greater than 1000 parts per million (ppm) at the open cleanout line in the basement floor. A draeger tube for total hydrocarbons registered 100 ppm at the cleanout line and drain. A reading in the breathing zone in the basement indicated 115 ppm total hydrocarbons. Readings taken in the first floor rooms ranged from 14 ppm to 22 ppm total hydrocarbons. In the second story bedroom, the reading was 8 ppm total hydrocarbons. Following this preliminary testing, the home was vented (i.e., the windows were opened) and the residents were advised to plug the cleanout line.

ATSDR received the OVA and draeger tube readings on October 15, 1999. Based on the total VOC and hydrocarbon readings, ATSDR's emergency response team recommended it would be prudent public health to vacate the residents of this home until chemical-specific air testing could be conducted. (The residents spent the next two nights at a motel, while air monitoring samples were being collected at their home.) On October 15, 1999, an air sample was collected from the basement sewer and submitted for chemical-specific analysis (see Table 3, Appendix B). After the chemical-specific results were reviewed, the residents were allowed to return to their home.

Between October 15 and October 17, 1999, additional chemical-specific air sampling (24-hour sampling

interval) was conducted in the living room and basement of this home. The sampling results are contained in Table 3, Appendix B. Benzene, chloroform, methylene chloride, tetrachloroethylene, and trichloroethylene exceeded health-based comparison values. All chemical-specific air sampling was conducted after the home was vented on the evening of October 14. The generally low levels of VOCs indicated that whatever had produced the odors detected on October 14, 1999, was no longer present in the home. The air sample taken at the drain on October 15 was analyzed for dozens of petroleum-related VOCs, with generally low levels (near or below the detection limit of 1 part per billion (ppb)) being recorded (Table 3, Appendix B). Hydrogen sulfide meter readings on October 16 at several locations in the basement indicated a range of 0 - 1 ppm (the maximum reading was detected at the cleanout line with the plug removed.)

EPA, Amoco, and ATSDR representatives attempted to determine whether anything on site could have triggered these releases. The sewer system was also investigated as a potential source of the reported odors. None of these investigations conclusively identified soil gas, contaminated groundwater, or the sewers as a source of the odors reported in this home on October 14, 1999.

5. TOXICOLOGICAL EVALUATION

In this section, ATSDR addresses the likelihood that exposure to contaminants at their maximum detected concentrations would result in adverse health effects at this site. The health implications, if any, of exposures can only be determined in the context of the best medical and toxicological information available. (Refer to Appendices C and D for additional information on comparison values and ATSDR's methodology.)

For the Norledge area, several of the chemicals detected in indoor air above health-based comparison values (for example, chloroform, methylene chloride, tetrachloroethylene, trichloroethylene, carbon tetrachloride, and 1,2-dichloroethane) have not been detected in the groundwater below the neighborhood and may be related to sources other than the refinery. Nevertheless, ATSDR evaluated the health implications of current chronic exposure to all chemicals detected in air above comparison values.

Monitoring events occurred in June, July, and October 1999. The June and July 1999 sampling events were specifically designed to gather air data that would aid in the assessment of chronic exposures. The October 1999 chemical-specific air data are included in this evaluation because ATSDR considers the data representative of chronic exposure levels (i.e., the reported odors had dissipated before chemical-specific testing was conducted.) ATSDR's primary focus is on those contaminants that were present at levels in excess of one or more health-based comparison value(s). Benzene exceeded ATSDR's intermediate environmental media evaluation guide (IEMEG) and ATSDR's cancer risk evaluation guide (CREG). Seven other chemicals (chloroform, methylene chloride, tetrachloroethylene, trichloroethylene, carbon tetrachloride, acrylonitrile, and 1,2-dichloroethane) exceeded their respective CREGs.

The highest levels of benzene, 57 and 70 micrograms per cubic meter ($\mu g/m^3$) (or 18 and 22 ppb, respectively), were detected in basements in June 1999; however, one of these homes was re-sampled in July 1999 and the highest level of benzene detected at that time was only 2.3 $\mu g/m^3$ (or 0.72 ppb) (Table 1, Appendix B). The median of the indoor air values for samples collected in June and July 1999 was 2.45 $\mu g/m^3$ (or 0.77 ppb) benzene. A review of the literature leads to the conclusion that no known adverse health effects in humans are associated with benzene exposures in the low parts-per-billion range (see Appendix E). Therefore, none of the estimated benzene exposures in the Norledge area would be expected to produce any adverse health effects of either a cancerous or non-cancerous nature.

The CREGs for chloroform, methylene chloride, tetrachloroethylene, and trichloroethylene are not derived from human exposure data. Rather, they are all based primarily on mouse liver tumors and male rat kidney tumors produced by species-specific mechanisms evidently dependent on unusually high doses. The induction of cancers in mice and rats by these compounds required doses in excess of anything humans might

reasonably be expected to encounter. They also involved certain elements of rodent biology that are not likely to be shared by humans. None of the available epidemiological (human) data suggests that any of these four chemicals represent a realistic cancer hazard at the levels detected in the Norledge area (ATSDR 1997a; ATSDR 1997b, ATSDR 1997c; ATSDR 1998).

No adverse effects have been observed in humans repeatedly exposed to 10-ppm carbon tetrachloride – 74,000 times the maximum levels detected indoors in the Norledge area (NIOSH 1981). Nor do any available data suggest a cause-and-effect relationship between carbon tetrachloride exposure and cancer in humans. Therefore, indoor air exposures to the levels of carbon tetrachloride detected in the Norledge area would not be expected to result in adverse health effects that are either cancerous or non-cancerous.

In the most reliable of the epidemiological studies on acrylonitrile, the incidence of cancer did not increase significantly in workers relative to unexposed workers followed over a period of 32 years (O'Berg 1980; O'Berg et al 1985; Collins et al 1989). Therefore, it is reasonable to conclude that the low levels of exposure in the Norledge area do not pose any realistic cancer risk to exposed residents.

In the study on which ATSDR based its chronic inhalation minimal risk level for 1,2-dichloroethane (Cheever et al 1990; ATSDR 2001), no increased carcinogenic (or non-carcinogenic) effects were seen in rats chronically exposed for 2 years to 50,000 ppb 1,2-dichloroethane. This is over 400,000 times the maximum exposures in the Norledge area. Therefore, indoor air exposures to the levels of 1,2-dichloroethane detected in the Norledge area would not be expected to result in adverse health effects.

Because the individual contaminants detected currently in indoor air at this site have consistently been present below levels that might be expected to result in adverse health effects, ATSDR considers that current exposures to the combined effect of all these contaminants is not likely to be of public health concern. This conclusion is based on studies suggesting that a mixture produces no adverse health effects in dosed animals when the components of that mixture are present at levels below their respective no-observed-adverse-effect levels (NOAEL); that is, at concentrations that would have produced no adverse effects in animals treated separately with those component chemicals (Wade et al 2002; Feron et al 1993; Jonker et al 1990; Jonker et al 1993; Groten et al 1991).

Groundwater and subsurface soil remedial activities in the Norledge area should result in decreasing contaminant concentrations in the future. Therefore, any potential contribution from these media to indoor air levels should decrease as well. At the maximum levels detected in indoor air in the Norledge area, neither benzene nor any of the other seven compounds that exceeded health-based comparison values currently poses a chronic health hazard to residents. For supporting toxicological information about ATSDR's evaluation, refer to Appendix E.

6. COMMUNITY CONCERNS EVALUATION

All of the following comments are in reference to an odor complaint registered by a Norledge area resident. ATSDR has addressed each of these comments in the following text. ATSDR's responses include information provided by personnel from, and contractors for, EPA, MDNR, Amoco, the Sugar Creek Fire Department, and the Department of Public Works, and from data and information obtained from the literature.

Comment 1: What could have caused the different readings on separate days of sampling?

Response: On October 14, 1999 – the day of the odor complaint – readings were taken using an OVA meter for total VOCs and draeger tubes for total hydrocarbons. Relatively non-specific and insensitive, OVA meters and draeger tubes are typically used only for screening or preliminary monitoring. During the next 2 days actual air samples for chemical analysis were collected using Summa canisters. These samples were analyzed using sensitive, chemical-specific techniques. In addition, on October 15 and 16 readings were taken using a

device with a photo-ionization detector (PID). Unlike the OVA meter used on October 14, which had a flame ionization detector and could register methane, the PID used during the next 2 days was not sensitive to methane. This differential sensitivity could account, at least partially, for the difference between readings taken at the open cleanout line on October 14 (1000 ppm total VOCs) and on October 16 (20 ppm), especially if sewer gas was a major component of the vapors present. The higher reading on October 14 might have reflected the presence of OVA-detectable methane while the lower reading on October 16 might have reflected the PID's insensitivity to methane. In addition to the differential sensitivities of the various devices and techniques used to monitor air contaminants during these 3 days, airing out the house on October 14 lowered true concentrations on the subsequent 2 days, especially if the original source was no longer present.

Comment 2: What other chemicals not included in the test results could account for the total vapor readings?

Response: As mentioned in the preceding response, sewer gases (e.g., methane and hydrogen sulfide) are a strong possibility. Because petroleum-related vapors were the central concern expressed by the residents, Summa canister samples collected on October 15 and 16 were not analyzed for methane. It could be significant, however, that, on October 16, a hydrogen sulfide meter read 1 ppm (or 1,000 ppb) at the open cleanout line, which is several orders of magnitude higher than the chemical-specific concentrations of petroleum-related VOCs detected in the Summa canister samples taken at the basement drain on October15 and 16. (See response to Comment 1.)

Comment 3: Why would solvents and trihalomethanes, such as chloroform and 1,1,1-trichloroethane, be in the air inside the resident's home?

Response: Solvents are ordinary ingredients in a variety of domestic products, including paints, paint thinners, varnishes, and glues. Such products are commonly stored in basements. Gasoline is also a principal source of solvent-related VOCs and gasoline is commonly stored in a basement. The devices fueled by gasoline are also major sources, for example, lawnmowers and, in basements with attached garages, automobiles and other gasoline-powered vehicles. Chloroform and 1,1,1-trichloroethane are present in many common domestic products. In addition, chloroform and other volatile trihalomethanes are present as disinfection byproducts in ordinary drinking water. Given the number of common domestic sources of these compounds, their detection at very low parts per billion levels in homes, and especially in basements, is to be expected and need not necessarily imply the existence of any external sources of pollution.

Comment 4: Has Amoco not fully characterized the pollution they caused, thereby avoiding more responsibility for the impacts to the public's health, as well as to the environment?

Response: ATSDR understands that Amoco's efforts to both characterize and remediate any pollution associated with their Sugar Creek facility represent an ongoing process that started years ago and continues to this day. Amoco is the most appropriate source for any detailed answer to questions about its activities and intentions. ATSDR is, however, the appropriate agency to which questions about "impacts to public health" should be addressed. To date, ATSDR has reviewed off-site data from the Norledge area through a series of public health assessment and health consultations. The available data for the Norledge area suggest that none of the detected contaminants currently pose a public health hazard.

Comment 5: To what extent were the chemicals detected in the house during and after the odor complaint hazardous to the health of the residents and to others who might have been exposed to them?

Response: ATSDR cannot comment on the potential health implications of the readings taken on October 14. Those readings gave little or no indication of exactly what compounds were present or at what concentrations. Indoor air samples taken on October 15 and 16 were subsequently analyzed for dozens of petroleum-related VOCs using sensitive chemical-specific techniques. None of the compounds detected in those samples were present at concentrations that would have been hazardous to the health of exposed

residents.

Comment 6: Given the odor incident at a Norledge area home on October 14th, can EPA, MDNR, or ATSDR guarantee that the residents are safe living in their own home?

Response: As stated in the previous response, ATSDR cannot comment on the potential health implications of the readings taken on October 14 during the odor event because the readings were not chemical-specific. However, ATSDR can state that at the maximum concentrations detected to date from chemical-specific data, none of the indoor air contaminants identified in Norledge area residences would be expected to produce adverse health effects.

Comment 7: It was odor that alerted the residents to a problem, yet benzene, the principal chemical of concern in the Norledge area, according to ATSDR, has no odor. Which of the chemicals detected in the home have an odor, and which ones don't?

Response: Like most aromatic substances, benzene does have an odor, but its threshold is around 1,500 ppb (1.5 ppm). Measured benzene concentrations at this home (and others) in the Norledge area have consistently been far below this odor threshold. Similarly, at sufficiently high concentrations, most of the individual petroleum-related VOCs detected at this residence on October 15 and 16 would also have odors. Like benzene, however, they too were generally present at concentrations well below their respective odor thresholds. As mentioned in the responses to comments 1 and 2, sewer gas (e.g., hydrogen sulfide) is an alternative source of the reported odors. The cleanout line in the basement, which bypasses the water trap on the basement drain, could have admitted sewer gas into the basement if it was left open for any reason. That line is reported to have been open on October 14 when odors were noted, closed the next day when no odors were noted, and open again on October 16 when odors were again reported by people on the scene (ATSDR 1999c). Also, a hydrogen sulfide meter registered 1 ppm at the cleanout line on October 16. Odor thresholds for hydrogen sulfide are said to range from 0.003 to 0.02 ppm.

Comment 8: What was the source of the odors reported by residents on October 14, 1999?

Response: Considering the known groundwater pollution in the Norledge area, petroleum-related contaminants were the residents' primary concern. An EPA contractor who responded to the call did characterize the smell as a "light petroleum-like odor." But two other people did not characterize the smell as a petroleum odor. Clearly, these subjective accounts do not provide a basis for any reliable conclusions. Nor do the readings taken in the home on October14, which were neither chemical-specific nor particularly sensitive, indicate what the actual source of the odors might have been. Whatever the odor was, it appeared to originate at an open cleanout line adjacent to the basement drain. An OVA reading taken at the open cleanout line on October 14 "pegged out" at 1000 ppm total VOCs (ATSDR 1999c). The house was aired out and the cleanout line was plugged.

The next morning a sample of air was taken at the basement drain with the cleanout line plugged. This sample was subsequently analyzed for dozens of petroleum-related contaminants, using sensitive, chemical-specific techniques. Two-thirds of these compounds were non-detects at the 1-ppb level – others ranged from barely detectable to 9.9 ppb. None of these compounds were of public health concern. No petroleum-like odors were apparent on October 15, and PID readings indicated nothing of a petroleum nature in the basement, inside the cleanout line, or in the sewer manholes near the home.

So then, what had produced the odors and high OVA readings of the day before and what could have caused them to disappear so completely overnight? Movements of soil gas and groundwater are usually slower than that. Also, an upgradient discharge into the sewer of a magnitude sufficient to produce strong odors and high OVA readings should have left a detectable residue of some kind the next morning, at least in the cleanout line and the sewer. In an effort to answer these questions, ATSDR contacted over a dozen different persons who had either been on the premises during the events of October 14-16, 1999, or who had received reports directly from others who were there.

A number of facts would seem to mitigate against petroleum-related pollution from groundwater or subsurface soil as the source of these odors. It now seems unlikely that such pollutants entered the home by way of the sewer system because

1. there had been no rain in the area for approximately 2 weeks (rain might raise the water table, displace soil gas from soil pore spaces, or both),
2. the groundwater table at the time was probably 25 feet, which is lower than the sewers in the area (18 feet),
3. the sewer system in this area is relatively new and the inside walls of the section of sewer near the home had been resin coated to seal off any possible vapor infiltration, and
4. the permeability of the top 5 feet of soil in this area is moderately slow.

Also, an OVA reading of 1000-ppm total VOCs (the reading at the cleanout line on October 14) cannot readily be accounted for by subterranean pollution. Even though a weathered gasoline odor was apparent near monitoring wells downgradient of this home in the vicinity of Amoco's interceptor trench, PID readings in these monitoring wells, which have direct access to the subterranean pollution, reportedly have not exceeded about 250 ppm total VOCs (ATSDR 1999c). A PID reading taken from monitoring well # A-26 during the odor response was only 24 ppm total VOCs.

Sewer gas is a possible alternative explanation for the odors reported on October 14. The cleanout line in the basement was open on October 14 when odors were initially reported; it was closed the next day when no odors were detectable and open again on October 16 when odors were again reported by those on the scene. A hydrogen sulfide meter registered 1 ppm (well above the odor threshold) at the cleanout line on October 16. Sewer gas would also be consistent with the high OVA reading on October 14 (OVAs are sensitive to methane) and the much lower PID readings on October 16 (PIDs are not sensitive to methane).

In spite of extensive efforts by EPA, MDNR, ATSDR, Amoco, contractors, and several city employees, it has not been possible to identify conclusively the source of the reported odors. A tentative conclusion would be that sewer gases admitted into the basement through an open cleanout line were the primary source of odors, with some petroleum-related VOCs of unknown origin being, at least, a possible contributor on October 14. MDNR and EPA have since established standard operating procedures for future odor events.

7. CHILD HEALTH CONSIDERATIONS

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults are; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health. Thus ATSDR is committed to evaluating their special interests at the Amoco Oil Company site.

Children who are the most likely to be exposed to indoor air contaminants are those living in homes in the Norledge area. Using available air data, none of the estimated contaminant exposures would be expected to produce any non-cancer, adverse health effects in children. In addition, none of the eight contaminants (acrylonitrile, benzene, carbon tetrachloride, chloroform, 1,2-dichloroethane, methylene chloride, tetrachloroethylene, and trichloroethylene) detected in indoor air at levels in excess of ATSDR's cancer risk evaluation guides (CREGs) poses a carcinogenic hazard to exposed children of the Norledge area.

8. CONCLUSIONS

Residents of the Norledge area of Sugar Creek, Missouri, are chronically exposed to indoor air contaminants. Although chronic inhalation exposures are currently occurring, the contaminant levels detected in indoor air are not likely to be associated with adverse health effects. ATSDR therefore categorizes current chronic exposures to indoor air in homes in the Norledge area as presenting **No Apparent Public Health Hazard** to Sugar Creek residents.

9. RECOMMENDATIONS

At this time, ATSDR has no specific recommendations with regard to current, chronic air exposures in the Norledge area.

10. PUBLIC HEALTH ACTION PLAN

The actions described in this section are designed to ensure that this public health assessment identifies public health hazards and provides a plan of action to mitigate and prevent adverse health effects resulting from exposure to hazardous substances in the environment. Where applicable, ATSDR includes a commitment to follow up on this plan and ensure that it is implemented.

Actions Completed:

- May 3, 1999: ATSDR reviewed and provided comments to the Missouri Department of Health regarding MDOH's report entitled "The Sugar Creek Cancer Inquiry Report - Level 2 Investigation, March 23, 1999."

- May 7, 1999: ATSDR released its first public health assessment for public review and comment. ATSDR concluded in the initial public comment version that the Norledge area of Sugar Creek poses an *Indeterminate Public Health Hazard*[(1)] because only limited data for indoor air were available and no data for surface soil were available. ATSDR's recommendations included sampling of indoor air and surface soil.

- May 1999: ATSDR released an easy-to-understand fact sheet summarizing our findings from the May 1999 public health assessment document. This fact sheet was included as an insert in the "Sweet Talk Newsletter" released in June 1999.

- June 2, 1999: ATSDR conducted a public meeting and public availability sessions during the comment period of the May 1999 public health assessment to address questions about the document and to collect additional community concerns.

- September 1999: ATSDR published an article in the "Sweet Talk Newsletter" to provide residents with an update on our activities in the Sugar Creek Community.

- March 29, 2000: ATSDR released this public health assessment addendum for public review and comment. ATSDR determined current, chronic exposures to the contaminant levels detected in indoor air are not likely to be associated with adverse health effects.

- April 2000: ATSDR released an easy-to-understand fact sheet summarizing our findings from the March 2000 public health assessment addendum. This fact sheet was included as an insert in the "Sweet Talk Newsletter" released in May 2000.

- April 12, 2000: ATSDR released for public review and comment its health consultation entitled "Review of January 2000 Air Data." ATSDR had received a request on March 10, 2000 from Amoco to review indoor air sampling results from eight Amoco-owned homes in the Norledge area. ATSDR determined that the contaminant levels detected during this indoor air sampling event are not likely to be associated with adverse health effects.

- May 1, 2000: ATSDR released for public review and comment its health consultation entitled "Review of February 2000 Soil Data." This document evaluated Norledge area surface soil data provided by the EPA. ATSDR concluded that no adverse health effects would arise from exposure to this soil during activities such as gardening or playing.

- June 27, 2000: ATSDR reviewed and provided comments to the Missouri Department of Health regarding MDOH's report entitled "The Sugar Creek Cancer Inquiry Report - Level 3 Investigation, March 3, 2000."

- August 28, 2000: ATSDR released for public review and comment its health consultation entitled "Surface Water and Sediment Data Review." This document evaluated surface water and sediment data provided by the Missouri Department of Natural Resources. Using the data provided, ATSDR determined that surface water and sediment contaminants are not a public health threat to residents in the Norledge neighborhood. Still, because the data were limited, ATSDR recommended additional surface water and sediment sampling in the off-site portions of Sugar Creek.

- November 29, 2000: ATSDR's May 1999 public health assessment was released in final form and included the agency's responses to comments received on the initial public comment version. ATSDR concluded that short-term exposures to the levels of contaminants detected in indoor air are not likely to be associated with adverse health effects. Potential intermittent exposures to subsurface soils would also be unlikely to result in adverse health effects. No exposures to groundwater were identified.

- December 8, 2000: ATSDR released final its health consultation entitled "Review of March 2000 Sediment and Surface Water Data" which evaluated surface water and sediment data provided by the Missouri Department of Natural Resources. Using the data provided, ATSDR determined that exposures to on-site surface water and sediment in the tank berms and off-site surface water and sediment in the drainage ditch and seepage areas would not be expected to result in adverse health effects. Nevertheless, because the data were limited, ATSDR recommended additional off-site surface water and sediment sampling in the seepage area and the drainage ditch.

- December 8, 2000: ATSDR released final its health consultation entitled "Indoor Air in Two Residences in the Norledge Area" which evaluated indoor air sampling data provided by the Amoco Oil Company. Reviewing the data provided, ATSDR determined indoor air exposures to the levels detected would not be expected to produce adverse health effects.

- December 19, 2000: ATSDR released final its health consultation entitled "Review of 1996 Water and Soil Data" which evaluated water and soil data from the Norledge area. Again using the data provided, ATSDR determined that exposures to water and soil by children playing in Sugar Creek should not result in adverse health effects. And again, because the data were limited, ATSDR recommended additional surface water and sediment sampling in Sugar Creek.

- April 23, 2001: ATSDR released final its health consultation entitled "Review of October 2000 Soil and Surface Water Data" which evaluated surface water and soil data provided by the Environmental Protection Agency. Using the provided data, ATSDR determined that intermittent exposures to surface water and subsurface soil in Sugar Creek and the seepage area would not be expected to result in adverse health effects.

- June 25, 2001: ATSDR released final its health consultation entitled "Review of Ambient Air Data" which evaluated ambient (i.e., outdoor) air sampling data collected by the Missouri Department of Natural Resources. Using the provided data, ATSDR determined ambient air exposures in the Norledge area would not be expected to produce adverse health effects.

- November 19, 2001: ATSDR provided technical assistance by reviewing the results of one surface water and one soil sample collected at the intersection of Carlisle and Northern streets in Sugar Creek, MO. ATSDR determined the water and soil samples indicated levels of chemicals that are unlikely to result in adverse health effects.

- September 17, 2002: ATSDR provided technical assistance to the Environmental Protection Agency by reviewing the results of surface water and sediment samples collected in Sugar Creek, MO. A review of the limited data provided led ATSDR to conclude that surface water and sediment samples indicated levels of chemicals that are unlikely to result in adverse health effects.

Actions Planned:

- ATSDR will evaluate additional environmental data for the Norledge area for public health significance, upon request. Results of these evaluations will be provided to the public in subsequent ATSDR documents.

11. PUBLIC COMMENT

ATSDR released this Amoco B Sugar Creek public health assessment addendum for public review and comment from March 29, 2000, through June 30, 2000. Appendix G contains both the comments received during the public comment period and ATSDR's responses to those comments.

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[1] The phrase "Indeterminate Public Health Hazard" is a formal conclusion category that ATSDR reserves for sites at which, due to the unavailability of critical information, no determination can be made regarding the existence or non-existence of a potential threat to health in the community.

PUBLIC HEALTH ASSESSMENT

Air Addendum

AMOCO-SUGAR CREEK
(a/k/a AMOCO-SUGAR CREEK)
SUGAR CREEK, JACKSON COUNTY, MISSOURI

A. FIGURES

Figure 1. Site Location Map

Figure 2. Intro Map

Figure 3. Norledge Area Air Sampling Locations - 1999

B. TABLES

Table 1: Off-site Air Benzene Levels*
Amoco - Sugar Creek, Missouri

Sampling Date	Benzene Levels at Home 1 (µg/m^3)	Benzene Levels at Home 2 (µg/m^3)	Benzene Levels at Home 3 (µg/m^3)	Benzene Levels at Home 4 (µg/m^3)	Benzene Levels at Home 5 (µg/m^3)	Benzene Levels at Home 6 (µg/m^3)	Benzene Levels at Home 7 (µg/m^3)	Benzene Outdoor Levels (µg/m^3)
June 1999	33 - 57	48 - 70	1.3 - 1.9	2.8 - 4.1	0.58 - 0.99	1.6 - 4.2	12 - 18	0.31 - 0.86
July 1999	0.81 - 2.3	NA	NA	2.1 - 2.5	NA	1.3 - 2.2	NA	0.40 - 2.4

* Source: Environmental Protection Agency. 1999. Indoor air report provided by Leland Grooms, EPA: analysis request report for activity: ELG01, description: basement sampling. EPA Region 7: Kansas City, Kansas.

ATSDR Benzene comparison values for the air media:
0.1 µg/m^3 or 0.03 ppb = Cancer Risk Evaluation Guide
13 µg/m^3 or 4 ppb = Intermediate Environmental Media Evaluation Guide
160 µg/m^3 or 50 ppb = Acute Environmental Media Evaluation Guide

µg/m^3 micrograms per cubic meter of air
NA not applicable (only three of the seven homes were re-sampled in July 1999)
ppb parts per billion

Table 2: Off-site Air Sampling Results for June and July 1999*
Amoco - Sugar Creek, Missouri

Compound†	**Indoor Concentration Range (µg/m^3)**	**Max. Conc. Sampling Location**	**Outdoor Concentration Range (µg/m^3)**	**Comparison Value (µg/m^3)**‡	
Acetone	ND - 1,700	Home 1	9.4 - 75	31,000 (13,000 ppb)	Chronic EMEG
Acrylonitrile	ND - 1.9	Home 2	ND - 1.3	0.01	CREG
				2	RfC
Allyl chloride	ND - 1.1	Home 1	ND	1	RfC
Benzene	0.58 - 70	Home 2	0.31 - 2.4	0.1	CREG
				13 (4 ppb)	IEMEG
Bromomethane	ND - 1.4	Home 1	ND	5.1	RBC (n)
Bromodichloromethane	ND - 0.25	Home 4	ND	0.1	RBC (c)
Butanal	ND - 42	Home 3	ND - 28	None	
1-Butanol	ND - 3.6 J	Home 1	ND - 3.3 J	370	RBC (n)
2-Butanol	ND - 0.56	Home 4	ND - 0.24 J	None	
2-Butanone	ND - 26	Home 2	0.81 - 11	1,000	RfC
Carbon disulfide	ND - 7.3	Home 3	ND - 3.2	930 (300 ppb)	Chronic EMEG
				700	RfC
Carbon tetrachloride	0.59 - 0.85	Home 3	0.59 - 0.83	0.07	CREG
				310 (50 ppb)	IEMEG
Chloroethane	ND - 0.27	Home 4	ND	10,000	RfC
Chloroform	ND - 7.1	Home 3	ND - 0.21	0.04	CREG
				98 (20 ppb)	Chronic EMEG
				240 (50 ppb)	IEMEG
Chloromethane	0.88 - 6.8	Home 7	ND - 1.2	103 (50 ppb)	Chronic EMEG
				410	IEMEG

				(200 ppb)	
Decane	ND - 20	Home 4	ND - 0.54	2,100 (600 ppb)	Chronic EMEG[b]
1,2-Dichlorobenzene	ND - 0.29	Home 1	ND - 0.43	33	RBC (n)
1,3-Dichlorobenzene	ND - 0.23	Home 1	ND	3.3 - 320	RBC (n) [§]
1,2-Dichloroethane	ND - 0.46	Home 4	ND	0.04	CREG
				810 (200 ppb)	Chronic EMEG
Ethyl benzene	ND - 46	Home 1	ND - 1.5	870 (200 ppb)	IEMEG
				1,000	RfC
Heptanal	ND - 63 J	Home 2	ND - 13	None	
Heptane	ND - 29	Home 1	ND	2,100 (600 ppb)	Chronic EMEG[¶]
Hexane	ND - 58	Home 2	ND - 2.6	2,100 (600 ppb)	Chronic EMEG
2-Hexanone	ND - 2.4	Home 2	ND - 1.2 J	None	
Isopropylbenzene	ND - 3.0	Home 1	ND	None	
Methylene Chloride	ND - 83	Home 3	1.3 - 14	3	CREG
				1,000 (300 ppb)	IEMEG
				1,000 (300 ppb)	Chronic EMEG
4-Methyl-2-pentanone (Methyl Isobutyl Ketone)	ND - 4.3	Home 2	ND - 0.61 J	205,000 (50,000 ppb)	TLV
2-Methyl-2-propanol (*tert*-butyl alcohol)	ND - 32	Home 1	ND - 0.43	303,000 (100,000 ppb)	TLV
Nonane	ND - 12 J	Home 1	ND - 0.56 J	2,100 (600 ppb)	Chronic EMEG[¶]
Octane	ND - 11	Home 2	ND - 0.26	2,100 (600 ppb)	Chronic EMEG[¶]
Pentanal (n-Valeraldehyde)	ND - 20	Home 4	0.82 - 18	176,000 (50,000 ppb)	TLV
Pentane	0.24 - 160	Home 2	0.52 - 3.8	1,770,000 (600,000 ppb)	TLV
2-Pentanone (Methyl Propyl Ketone)	ND - 11	Home 1	ND - 3.7 J	705,000 (200,000 ppb)	TLV
3-Pentanone (Diethyl Ketone)	ND - 1.9	Home 1	ND - 0.40	705,000 (200,000 ppb)	TLV
Propanal (Propionaldehyde)	ND - 82 J	Home 2	1.7 - 59	240** (100 ppb)	
1-Propanol	ND - 4.3	Home 3	ND - 0.93	Only slightly more toxic than isopropyl	

(n-Propyl Alcohol)				alcohol. (See isopropyl alcohol.)	
2-Propanol (Isopropyl Alcohol)	ND - 50	Home 2	ND - 5.1	Used in after shave & rubbing alcohol. Not significantly toxic below 980,000 ug/m^3 (400,000 ppb).	
Styrene	ND - 7	Home 2	ND	255 (60 ppb)	Chronic EMEG
				1,000	RfC
Tetrachloroethylene	ND - 11	Home 4	ND - 0.43	2	CREG
				270 (40 ppb)	Chronic EMEG
Toluene	0.97 - 380	Home 1	0.97 - 9.9	3,800 (1,000 ppb)	Chronic EMEG
1,2,4-Trichlorobenzene	ND - 1.0	Home 1	ND	210	RBC (n)
1,1,1-Trichloroethane	0.35 - 19	Home 7	0.55 - 3.6	3,800 (700 ppb)	IEMEG
Trichloroethylene	ND - 3.4	Home 2	ND	0.6	CREG
				540 (100 ppb)	IEMEG
1,1,2-Trichlorotrifluoroethane	ND - 0.76	Home 1	ND - 190	7,670,000 (1,000,000 ppb)	TLV
1,2,4-Trimethylbenzene	ND - 64	Home 1	ND - 3.2	123,000 (25,000 ppb)	TLV
1,3,5-Trimethylbenzene	ND - 17	Home 7	17ND - 0.6	123,000 (25,000 ppb)	TLV
Xylenes - ortho	ND - 52	Home 1	ND - 1.9	434,000 (100,000 ppb) (o-, m-, p-isomers)	TLV
Xylene, m and/or p	ND - 180	Home 1	ND - 4.7	430 (100 ppb)	Chronic EMEG

* Source: Environmental Protection Agency. 1999. Indoor air report provided by Leland Grooms, EPA: analysis request report for activity: ELG01,description: basement sampling. EPA Region 7: Kansas City, Kansas.

† Only those compounds detected in at least one of the sampling rounds are included in the table (that is, VOCs not detected in any round of sampling were not included in the table).

‡ The units for the comparison values are in µg/m^3 unless otherwise specified.

§ Based on different risk assessments from different EPA sources, EPA Region III has calculated several different RBCs for 1,3-dichlorobenzene in air during the last 2 years or so. All of them incorporated substantial margins of safety and represented safe levels of chronic, lifetime exposure. Considering the scarcity of relevant health effects data available for this compound, the lower estimates most likely reflect differences in methodology, and not new evidence of greater toxicity. The available human and animal data do not suggest that 1,3-dichlorobenzene at low levels poses any threat to human health.

¶ The chronic EMEG for n-Hexane can be used as a conservative surrogate for higher homologues of n-Hexane for which there are no chemical-specific comparison values (e.g., pentane, heptane, octane, nonane, and decane), because the toxicity of straight-chain alkanes tends to decrease with increasing chain length.

** There are no comparison values for propanal (propionaldehyde). However, rats tolerated inhalation of 90,000 ppb of

propionaldehyde, for 20 days, 6 hr/day, with no obvious pathology. Also, ATSDR has not listed any toxic effects levels for the related aldehyde acrolein (2-propenal) below 100 ppb, and acrolein is much more toxic than is propanal. Therefore, the 100 ppb level can be safely assumed to be a highly conservative no-effect level for propanal.

CREG	Cancer risk evaluation guide
EMEG	Environmental media evaluation guide
IEMEG	Intermediate environmental media evaluation guide
J	Estimated concentration
ND	Not detected
ppb	Parts per billion
RBC(n)	Risk based concentration - noncancer
RfC	Reference concentration
RMEG	Reference dose media evaluation guide
TLV	Threshold limit value
$\mu g/m^3$	micrograms per cubic meter of air

Table 3: Off-site Indoor Air Sampling Results for October 1999*
Amoco - Sugar Creek, Missouri

Compound†	**Sample 002**‡ **Conc. (ppb)**	**Sample 003**§ **Conc. (ppb)**	**Sample 004**¶ **Conc. (ppb)**	**Sample 005**** **Conc. (ppb)**	**Sample Concentration at Basement Drain on 10/15/99 (ppb)**	**Comparison Value (ppb)**††	
Benzene	ND	2.0	1.4	1.6	1.1	0.03 (0.1 $\mu g/m^3$)	CREG
						4	IEMEG
Chloroform	ND	1.1	ND	1.4	ND	0.008 (0.04 $\mu g/m^3$)	CREG
						20	Chronic EMEG
						50	IEMEG
1,2-Dichlorobenzene	ND	1.8	ND	ND	ND	5.5 (33 ug/m^3)	RBC (n)
1,3-Dichlorobenzene	ND	5.8	4.6	6.6	1.1	0.55 - 53 (3.3 - 320 ug/m^3)	RBC (n)‡‡
1,4-Dichlorobenzene	ND	1.4	ND	ND	ND	200	IEMEG
						100	Chronic EMEG
Dichlorodifluoromethane	ND	2.1	2.3	1.7	1.6	1,000,000 (4,950,000 ug/m3)	TLV
Ethyl benzene	ND	3.9	2.9	3.5	2.1	200	IEMEG
Methylene Chloride	ND	1.4	ND	ND	1.0	0.9	CREG

						(3 µg/m)	
						300	IEMEG
						300	Chronic EMEG
Styrene	ND	10.5	9.6	13.1	1.6	60	Chronic EMEG
1,1,2,2-Tetrachloroethane	ND	2.0	ND	ND	ND	1,000 (6,900 ug/m^3)	TLV
Tetrachloroethylene	ND	ND	ND	ND	1.0	0.3 (2 µg/m^3)	CREG
						40	Chronic EMEG
Toluene	ND	20.8	13.7	16.7	8.6	1,000	Chronic EMEG
1,1,1-Trichloroethane	ND	1.4	2.2	1.1	ND	700	IEMEG
1,1,2-Trichloroethane	ND	2.0	2.0	ND	ND	10,000 (55,000 ug/m^3)	TLV
Trichloroethylene	ND	ND	ND	ND	1.0	0.12 (0.6 µg/m^3)	CREG
						100	IEMEG
Trichlorofluoromethane	ND	2.8	3.5	2.2	1.6	1,000,000	STEL
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	ND	ND	ND	1.0	1,000,000	TLV
1,2,4-Trimethylbenzene	ND	9.8	5.9	5.9	3.7	25,000	TLV
1,3,5-Trimethylbenzene	ND	1.34	7.6	9.4	1.6	25,000	TLV
Xylenes - ortho	ND	4.1	2.2	2.5	2.2	100,000 (o-, m-, p- isomers)	TLV
Xylene, m and/or p	ND	19.7	10.5	11.4	9.9	100	Chronic EMEG

* Sources: Agency for Toxic Substances and Disease Registry. 1999. October 21 fax sent by Denise Jordan-Izaguirre, ATSDR, to Danielle Langmann, ATSDR, concerning air sampling results (sample number: B85745, laboratory report: 99IH3502). Atlanta: US Department of Health and Human Services.

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† Only those compounds detected in at least one of the sampling rounds are included in the table (that is, VOCs not detected in any round of sampling were not included in the table).

‡ Sample 002: Collected in the living room 10/15/99 - 10/16/99

¶ Sample 003: Collected in the basement 10/15/99 - 10/16/99

§ Sample 004: Collected in the living room 10/16/99 - 10/17/99

** Sample 005: Collected in the basement 10/16/99 - 10/17/99

†† The units for the comparison values are in ppb unless otherwise specified.

‡‡ Using different risk assessments from different EPA sources, EPA Region III has calculated several different RBCs for 1,3-dichlorobenzene in air during the last 2 years or so. All of them incorporated substantial margins of safety and represented safe levels of chronic, lifetime exposure. Considering the scarcity of relevant health effects data available for this compound, the lower estimates most likely reflect differences in methodology, and not new evidence of greater toxicity. The available human and animal data do not suggest that 1,3-dichlorobenzene at low levels poses any threat to human health.

CREG	Cancer risk evaluation guide
EMEG	Environmental media evaluation guide
IEMEG	Intermediate environmental media evaluation guide Table 3 (page 4 of 4).
J	Estimated concentration
ND	Not detected
ppb	Parts per billion
RBC(n)	Risk based concentration - noncancer
RfC	Reference concentration
RMEG	Reference dose media evaluation guide
STEL	Short term exposure limit
TLV	Threshold limit value
$\mu g/m^3$	micrograms per cubic meter of air

C. COMPARISON VALUES

ATSDR comparison values are media-specific concentrations considered safe under default conditions of exposure. They are used as screening values in the preliminary identification of site-specific "contaminants of concern." The latter term should not be misinterpreted as an implication of "hazard." As ATSDR uses the phrase, a "contaminant of concern" is a chemical substance detected at the site in question and selected by the health assessor for further evaluation of potential health effects. Generally, a chemical is selected as a "contaminant of concern" because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's comparison values.

It must however be emphasized that comparison values are not thresholds of toxicity. Although concentrations at or below the relevant comparison value can reasonably be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. The principal purpose behind protective health-based standards and guidelines is to enable health professionals to recognize and to resolve potential public health hazards before they become actual public health consequences. For that reason, ATSDR's comparison values are typically designed to be 1 to 3 orders of magnitude (or 10 to 1,000 times) lower than the corresponding no-effect levels (or lowest-effect levels) on which they are based. The probability that such effects will actually occur depends not on environmental concentrations alone. Rather, the probability depends on a unique combination of site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure.

Listed and described below are the various comparison values that ATSDR uses to select chemicals for further evaluation, as well as other non-ATSDR values that are sometimes used to put environmental concentrations into a meaningful frame of reference.

CREG = Cancer Risk Evaluation Guide

MRL = Minimal Risk Level

EMEG = Environmental Media Evaluation Guide

IEMEG = Intermediate Environmental Media Evaluation Guide

RMEG = Reference Dose Media Evaluation Guide

RfD = Reference Dose

RfC = Reference Concentration

RBC = Risk-Based Concentration

MCL = Maximum Contaminant Level

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors, or cancer potency factors, using default values for exposure rates. It should be noted, however, that neither CREGs nor cancer slope factors can be used to make realistic predictions of cancer risk. The true cancer risk is always unknown and could be as low as zero.

Minimal Risk Levels (MRLs) are estimates of daily human exposure to a chemical (doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of deleterious noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are reported for acute (≤14 days), intermediate (15-364 days), and chronic (≥365 days) exposures. MRLs are published in ATSDR toxicological profiles for specific chemicals.

Environmental Media Evaluation Guides (EMEGs) are concentrations derived from ATSDR minimal risk levels by factoring in default body weights and ingestion rates.

Intermediate Environmental Media Evaluation Guides (IEMEGs) are calculated from ATSDR minimal risk levels; they factor in body weight and ingestion rates for intermediate exposures (those occurring for more than 14 days and less than 1 year).

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like ATSDR's MRL, EPA's RfD is a dose expressed in mg/kg/day.

Reference Concentrations (RfC) is a concentration of a substance in air that EPA considers unlikely to cause noncancer adverse health effects over a lifetime of chronic exposure.

Risk-Based Concentrations (RBCs) are media-specific concentrations derived by Region III of the Environmental Protection Agency from RfD's, RfC's, or EPA's cancer slope factors. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) considered unlikely to cause adverse health effects over a lifetime of chronic exposure. RBCs are based either on cancer ("c") or noncancer ("n") effects.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

Threshold Limit Values (TLVs) are time-weighted average concentrations for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without

adverse effect.

D. METHODOLOGY OF EVALUATING CHEMICALS OF CONCERN

ATSDR addresses the question of whether exposure to contaminants at the maximum concentrations detected would result in adverse health effects. While the relative toxicity of a chemical is important, the human body's response to a chemical exposure is determined by several additional factors, among which are

- the concentration (how much) of the chemical to which the person was exposed,
- the amount of time the person was exposed (how long),
- the way the person was exposed (through breathing, eating, drinking, or direct contact with something containing the chemical), and
- Lifestyle factors (for example, occupation and personal habits) have a major impact on the likelihood, magnitude, and duration of exposure. Individual characteristics such as age, sex, nutritional status, overall health, and genetic constitution affect how the human body absorbs, distributes, metabolizes, and eliminates a contaminant. A unique combination of all these factors will determine the individual's physiologic response to a chemical contaminant and any adverse health effects the individual could suffer as a result of the chemical exposure.

ATSDR evaluates contaminants detected in environmental media at a site and determines whether an exposure to them has public health significance. ATSDR begins this evaluation by gathering reports that contain relevant environmental data for the site. These data are reviewed to determine whether contaminant levels are above health-based comparison values. Health-based comparison values are estimates of the daily human exposure to a substance that are not likely to result in adverse health effects over a specified duration of exposure. These values are developed for specific media (such as air and water) and for specific durations of exposure (such as acute and chronic).

Health-based comparison values represent conservative levels of safety and not thresholds of toxicity. Thus, although concentrations at or below a comparison value may reasonably be considered safe, concentrations above a comparison value will not necessarily be harmful. Comparison values are intentionally designed to be much lower, usually by orders of magnitude, than the corresponding no-effect levels (or lowest-effect levels) determined in laboratory studies to ensure that even the most sensitive populations (such as children or the elderly) are protected.

To determine whether people are being exposed to contaminants or whether they were exposed in the past or will be exposed in the future, ATSDR examines the path between a contaminant and a person or group of people who could be exposed. Completed exposure pathways have five required elements. ATSDR evaluates each possible pathway at a site to determine whether all five factors exist and whether people are being exposed, were exposed, or could in the future be exposed. The following five factors or elements must exist for a person to be exposed to a contaminant:

1. A source of contamination,
2. transport through an environmental medium,

3. a point of exposure,

4. a route of human exposure, and

5. an exposed population.

ATSDR classifies exposure pathways in one of the following three categories.

- *Completed Exposure Pathway*. ATSDR calls a pathway "complete" if it is certain that people are exposed (or were exposed or will be exposed) to contaminated media. Completed pathways require that the five elements exist and indicate that exposure to the contaminant has occurred, is occurring, or will occur.

- *Potential Exposure Pathway.* Potential pathways are those in which at least one of the five elements is missing, but could exist. Potential pathways indicate that exposure to a contaminant could have occurred, could be occurring, or could occur in the future.

- *Eliminated Exposure Pathway*. In an eliminated exposure pathway, at least one of the five elements is missing and will never be present. From a human health perspective, pathways can be eliminated from further consideration if ATSDR is able to show that 1) an environmental medium is not contaminated, or that 2) no one is exposed to contaminated media.

E. SUPPORTING TOXICOLOGICAL INFORMATION

The information in this appendix provides an in-depth review of the eight chemicals that exceeded health-based comparison values in air in the Norledge area (Sections 1 and 2). A discussion on the combined effect of these contaminants is covered in Section 3. In Section 4 ATSDR describes for the selected chemicals of concern the various cancer classifications of the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), the Environmental Protection Agency (EPA), and the American Conference of Governmental Industrial Hygienists (ACGIH).

1 Benzene

1.1 General Benzene Information

Benzene (benzol or coal tar naphtha) is a known human carcinogen, and is classified as such by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC), the Environmental Protection Agency (EPA), and the American Conference of Governmental Industrial Hygienists (ACGIH).

Benzene is a common solvent isolated from coal tar and crude oil. Although it is naturally released into the atmosphere as an emission of volcanos, forest fires, and even many plants, the primary sources of benzene exposure for the general population are tobacco smoke (50%), automobile service stations, vehicle exhaust and industrial emissions (20%), and vapors from benzene-containing household products such as glues, paints, furniture wax, and some detergents (ATSDR 1997a). Environmental exposure to benzene has been reviewed by the EPA (Wallace 1996). More than 99% of personal exposure to benzene is through the air, averages about 15 $\mu g/m^3$ (4.7 ppb) and ranges from 7 to 29 $\mu g/m^3$ (2 to 9 ppb). These values reflect the results of EPA's Total Exposure Assessment Methodology (TEAM), a study conducted between 1980 and

1987 using personal air quality monitors to measure direct personal exposures in about 800 persons around the United States. This sample was designed to be representative of the non-occupational exposure of 800,000 people in these areas.

Due partly to the domestic use of household products and due partly to home insulation, indoor air concentrations (on the order of 10 µg/m^3 or 3.1 ppb) typically exceed outdoor air concentrations, which average 6 µg/m^3 (1.9 ppb) and range from 2 to 19 µg/m^3 (0.6 to 5.9 ppb). (Note: air concentrations of benzene can be converted from µg/m^3 to ppb by dividing by 3.2, or from ppb to µg/m^3 by multiplying by 3.2.) Levels in the city are generally higher than those in rural areas. Average rural background levels of benzene in air historically range from 0.1 to 17 ppb (IARC 1982). More current figures for the range of average rural background levels in the U.S. are not available. Still, 1986 statewide average levels at about 20 sites throughout California fluctuated between 1.6 and 2.2 ppb until 1993 and 1994 when they dropped to about 1.25 ppb, probably as a result of various actions taken to reduce automobile emissions (Wallace 1996). Average levels were higher in winter and lower in summer.

In smokers, the benzene in mainstream cigarette smoke overwhelms all other sources combined. The average smoker could be exposed to 10 times as much benzene as is the average non-smoker (Wallace 1996). For non-smokers, most benzene exposure is ultimately derived from automobile exhaust and gasoline vapor emissions (Egeghy et al 2000). No significant effect on personal exposure has been detected in persons living close to major fixed sources of benzene, such as oil refineries, storage tanks, and chemical plants (Wallace 1996).

1.2 Evaluation of Site-Specific Benzene Exposures

Benzene was detected in indoor air above health-based comparison values during the June, July, and October 1999 sampling events (see Tables 1 and 3, Appendix B). The highest levels, 57 and 70 µg/m^3, were detected in basements in June 1999; however, one of these homes was re-sampled in July 1999 and the highest level of benzene detected at that time was only 2.3 µg/m^3 (Table 1, Appendix B).

The median of the indoor air values for samples collected in June and July 1999 was 0.77 ppb (or 2.45 µg/m^3) benzene. Therefore, average chronic exposures in the Norledge area, like those across the country, are in the low ppb range. Although nationwide background levels, like those in the Norledge area, can often exceed ATSDR's cancer-based screening value for benzene (0.1 µg/m^3 or 0.03 ppb), no adverse health effects, including cancer, would be expected (see clarification in the following text).

Benzene detected in two Norledge area homes ranged from 33 to 70 µg/m^3. The concentrations detected in these two homes, as well as the maximum level detected in a third home (18 µg/m^3) during the June 1999 round of sampling, exceeded ATSDR's intermediate environmental media evaluation guide (IEMEG) of 4 ppb or 13 µg/m^3. This health-based comparison value represents a concentration of benzene in air that is not likely to result in adverse health effects for exposures lasting from 2 weeks to a year. This particular intermediate EMEG is based on a behavioral effect, i.e., a facilitated aversion response observed in male Kunming mice exposed to 780 ppb (2,496 ug/m^3) benzene for 2 hours a day, 6 days a week, for 30 days (Li et al 1992). To avoid an electrical shock, mice exposed to 780 ppb benzene found their way to a safe area at the end of a "Y" maze more quickly, on average, than did untreated control mice. The intermediate EMEG based on this observed effect includes a safety factor of 90. The maximum concentration of benzene detected in indoor air of Norledge area homes (70 µg/m^3 or 22 ppb) exceeded this comparison value by only 6% of the incorporated safety factor. ATSDR considers that no adverse health effects would be expected at such levels.

The lowest human effect levels reported in ATSDR's recently updated ATSDR Toxicological Profile for Benzene; that is, 690 ppb for leukopenia (Xia et al 1995) and 300 ppb for leukemia (Ott et al 1978), are 31 and 13 times higher, respectively, than the highest level of benzene detected in indoor air in the Norledge

area. These values (690 ppb and 300 ppb) represent the lowest measured concentrations in a range of industrial hygiene measurements in each facility in the two studies, which were 690 to 140,000 ppb and 300 to 35,000 ppb, respectively. Use of the lowest measured concentration as an indicator of exposure in the facilities is conservative and will likely underestimate actual exposures. Assuming a normal dose-response relationship in which lower doses are less toxic than higher ones and consistent with the epidemiological and toxicological literature (Paustenbach et al 1992; Rinsky et al 1987; Wong 1995), any adverse effects caused by benzene would be expected to occur in workers exposed to the higher, rather than the lower, end of those exposure ranges. In an update of the Ott study, it was noted that "workers who died of leukemia had the potential for unquantified, but potentially high, exposures to benzene" (Bond et al 1986).

ATSDR's benzene CREG is based primarily on studies of U.S. workers (the Pliofilm cohort) exposed to high levels of benzene (up to hundreds of ppm or hundreds of thousands of ppb) during rubber manufacture, mostly during the 1940s. Like all CREGs, it is based on an EPA-estimated cancer slope factor which is in turn based on the assumption that the dose-response relationship is constant with dose; that is, that the proportion of effects seen at high doses will be the same in the low-dose range where the effects are unmeasurable.

Available studies indicate no detectable excess of leukemia below cumulative exposures of 40 ppm-years (Rinsky et al 1987). This would be numerically, if not biologically, equivalent to about 190 ppb, 24 hours a day, over a 70-year lifetime. However, this apparent threshold is most likely an underestimate because it is based on underestimated exposures and the inclusion of all leukemias, not just AML. When only AML is considered, the estimated threshold was found to be at least 200 ppm-years (numerically equivalent to 950 ppb, 24 hours a day, over a 70-year lifetime), based on the original set of exposure estimates, and higher still using later, more accurate exposure estimates (Paustenbach et al 1992; Wong 1995). (The notation "ppm-year" represents a numerical attempt to integrate the levels and durations of exposure observed in occupational studies as a product of the two. A worker exposed to 2 ppm for 20 years and one exposed to 20 ppm for 2 years both received the "same" cumulative exposure that is, expressed in ppm-years. The distinction is made between numerical and biological equivalence because, although an aspirin a day for 70 years would be numerically equivalent to 70 aspirin a day for 1 year, the two dose rates would produce very different biological effects. Although the first dose regimen might protect one from cardiovascular disease the second would be lethal.)

For the reasons discussed in this section, none of the estimated benzene exposures in the Norledge area would be expected to produce any adverse health effects of either a cancerous or non-cancerous nature.

2 Evaluation of Site-Specific Exposures: Other Chemicals

Other than benzene, no indoor air contaminant was detected at levels in excess of any of ATSDR's non-cancer comparison values. CREGs were exceeded by the maximum detected concentrations of seven other compounds listed in Tables 2 and 3 (Appendix B). The highest levels of chloroform (7.1 $\mu g/m^3$), methylene chloride (83 $\mu g/m^3$), tetrachloroethylene (11 $\mu g/m^3$), trichloroethylene (3.4 $\mu g/m^3$), carbon tetrachloride (0.85 ug/m^3), 1,2-dichloroethane (0.46 ug/m^3), and 1,1,1-trichloroethane (19 ug/m^3) detected in indoor air exceeded ATSDR's CREGs of 0.04, 3.0, 2.0, 0.6, 0.07, 0.04, and 0.6 ug/m^3, respectively. None of these contaminants, however, pose a current cancer hazard to Sugar Creek residents (see following text).

2.1 Methylene Chloride

The CREG for methylene chloride is based on inhalation studies in mice exposed 6-hours a day, 5 days a week, for life (104 weeks) to 2,000,000 ppb or 7,000,000 $\mu g/m^3$ methylene chloride. Several, more-relevant, epidemiological studies have detected no excess risk of cancer deaths in workers exposed to methylene chloride at levels up to 475,000 ppb or 1,650,000 $\mu g/m^3$ (ATSDR 1998). Therefore, chronic exposures to methylene chloride at the levels detected in Norledge area homes would not be expected to result in cancer.

2.2 Tetrachloroethylene (PCE)

ATSDR's CREG for tetrachloroethylene or PCE, a non-genotoxic animal carcinogen, was originally based on cancer risk assessment which EPA withdrew some 12 years ago; a more up-to-date assessment is not available (IRIS 1999). In the chronic bioassays on which this risk assessment was based (NTP 1986; ATSDR 1997c), doses of 100,000-200,000 ppb PCE administered by inhalation produced liver cancer in mice (but not in rats); at 200,000-400,000 ppb, it also caused a statistically insignificant increase in kidney tumors in male (but not female) rats (ATSDR 1997c). The PCE-related tumors produced in these studies required doses in excess of anything humans might reasonably be expected to encounter and appear to have involved species-specific mechanisms likely in humans to be either inoperative or much less pronounced (Green 1990). PCE has also been extensively studied in dry cleaning workers whose exposure typically exceeds that of Sugar Creek residents by several orders of magnitude (ATSDR 1997c). None of the epidemiological data suggests that the levels of PCE detected in Norledge area homes represent a realistic cancer hazard.

2.3 Trichloroethylene (TCE)

ATSDR's CREG for trichloroethylene or TCE (another largely non-genotoxic animal carcinogen) was also originally based on a cancer risk assessment which EPA withdrew a decade ago and still has "under review" (IRIS 1999). EPA's original cancer risk assessment for TCE was based on lung tumors seen in mice (but not rats) at high doses (e.g., µ150, µ300, and µ600 ppm in 3 different strains of mice), but not at lower doses (ATSDR 1989). When administered orally, TCE also induces liver tumors in mice (but not rats) and kidney tumors in male rats (but not mice or female rats). As in the case of PCE, these tumors appear to be dependent on both extremely high doses and on high-threshold, species-specific mechanisms of action that are weak or non-existent in humans (Green 1990). In yet another similarity with PCE, numerous occupational studies of inhalation exposure to TCE in workers have yielded generally negative results for cancer (ATSDR 1997d). Therefore, chronic exposure to the levels detected in Norledge area homes would not be expected to result in cancer.

2.4 Chloroform

Concentrations of chloroform in indoor air at Sugar Creek (non-detect to 7.1 $\mu g/m^3$) are below ATSDR's chronic inhalation MRL of 20 ppb (98 $\mu g/m^3$). Therefore, air exposures are not expected to result in any non-cancer adverse health effects. Because "chloroform is not likely to be carcinogenic to humans by any route of exposure under exposure conditions that do not cause cytotoxicity and cell regeneration" (EPA 2001), comparison values that are protective of non-cancer adverse health effects would also protect against cancer. Therefore, because the ATSDR MRL was not exceeded, there is accordingly no basis for expecting that the levels detected in indoor air in Norledge area homes would represent a cancer hazard.

2.5 Carbon Tetrachloride

Carbon tetrachloride is a potent hepatotoxin, nephrotoxin, and central nervous system (CNS) depressant at high doses and is a liver carcinogen in animals. But no adverse effects have been observed in humans repeatedly exposed to 10 ppm, which is 74,000 times the maximum levels detected indoors in the Norledge area (NIOSH 1981), nor do any existing data suggest a cause-and-effect relationship between carbon tetrachloride exposure and cancer in humans. Like the chloroform CREG, the CREG for carbon tetrachloride is based on an inhalation cancer risk estimate which EPA derived from oral dose-response data on liver tumors in rodents. Therefore, indoor air exposures to the levels of carbon tetrachloride detected in the Norledge area would not be expected to result in cancerous or non-cancerous adverse health effects in exposed residents.

2.6 Acrylonitrile

In the most reliable of the epidemiological studies on acrylonitrile, cancer incidence did not increase

significantly in 1,345 male textile workers – relative to unexposed workers – followed over a period of 32 years (O'Berg 1980; O'Berg et al 1985). Using his original results, O'Berg (1980) concluded that an association with lung cancer might exist, but that any possible association was weaker in O'Berg's follow-up study (O'Berg et al 1985). Also, in another well-designed epidemiological study, no association with lung cancer was detected in 1,774 male workers with known acrylonitrile exposure and 32 years of follow up (Collins et al 1989). EPA's cancer risk assessment for acrylonitrile (and, hence, ATSDR's CREG) was based on the statistically insignificant excess incidence of respiratory cancer seen in the O'Berg (1980) study after adjusting for smoking (IRIS 1999). Given the weakness of this potential association in the original study and its decline or absence in subsequent studies of workers with significant occupational exposure, ATSDR considers that the lower levels of indoor air exposure in the Norledge area do not pose any realistic cancer risk to exposed residents.

2.7 1,2-Dichloroethane

As in the case of carbon tetrachloride, EPA's inhalation cancer risk estimate for 1,2-dichloroethane was extrapolated from an old, positive, oral bioassay in rats gavaged daily with over a 100,000 times the maximum estimated doses in the Norledge area. In the study on which ATSDR based its chronic inhalation minimal risk level for 1,2-dichloroethane (Cheever et al 1990; ATSDR 2001), no increased carcinogenic (or non-carcinogenic) effects were seen in rats chronically exposed for 2 years to 50,000 ppb 1,2-dichloroethane; that is, over 400,000 times the maximum exposures in the Norledge area. Therefore, indoor air exposures to the levels of 1,2-dichloroethane detected in the Norledge area would not be expected to result in cancer or any other adverse health effects.

In conclusion, at the maximum levels detected in indoor air in the Norledge area, neither benzene nor any of the other seven compounds which exceeded ATSDR's CREGs pose a carcinogenic hazard to residents under site-specific conditions of exposure.

3 Evaluation of Site-Specific Exposures: Mixtures

Because the individual contaminants detected at the site are present at levels below those that might be expected to result in adverse health effects, ATSDR considers that the combined effect of all these contaminants is not likely to be of public health concern.

This conclusion is based on studies suggesting that a mixture does not produce noncarcinogenic adverse health effects in dosed animals when the components of that mixture are present at levels below their respective no-observed-adverse-effect levels (NOAELs); that is, at concentrations which would have produced no adverse effects in animals treated separately with the individual chemicals (Feron et al. 1993; Jonker et al. 1990; Jonker et al. 1993a; Jonker et al. 1993b; Groten et al. 1991). In two of these experiments (Jonker et al. 1993a; Jonker et al. 1993b) all of the component chemicals affected the same target organ, but through different mechanisms. In two others (Jonker et al. 1990; Groten et al. 1991), the chemicals had different target organs and exhibited different modes of action, as do most chemicals in typical environmental mixtures. Subsequent experiments have shown similar results (Feron et al. 1995; Groten et al. 1997).

Especially relevant is a recent study by Wade et al. (2002) in which animals were exposed for 70 days to a mixture of 16 different organochlorines (including dioxin, polychlorinated biphenyls, DDT and several other pesticides) and two metals (lead and cadmium). Each substance was present at the minimum risk level (MRL) or tolerable daily intake (TDI), or, for dioxin, at the no-observed-effect level (NOEL) used to calculate the TDI. No adverse health effects were observed.

United States regulatory agencies assume, for conservative public health policy, that carcinogens exhibit no threshold other than zero dose (the "zero-threshold assumption"). But because of biological safeguards, such as compensatory mechanisms and repair processes, carcinogens exhibit practical thresholds in the laboratory, as do non-carcinogens (SOT 1981; Williams and Weisburger 1991, page 152-5; Cunningham et al. 1994; Pitot and Dragan 1996, page 254-5; Waddel 2003). It is likely that the principle described in the previous

paragraphs will be applicable to carcinogens as well as to noncarcinogens; animal evidence supports this principle. When Hasegawa et al. (1994) administered 10 carcinogenic heterocyclic amines in combination to rats at 1/100 of the doses known to be carcinogenic individually, the effects did not differ significantly from controls. These doses were 100 times lower than established cancer effect levels. Environmental levels of exposure that humans encounter are typically much lower by many orders of magnitude. These results suggest that mixed exposures to carcinogens below all known adverse effects levels are unlikely to pose any demonstrable carcinogenic risk to exposed humans.

The above research findings support the conclusion that because the individual contaminants detected at this site were present at levels well below those that might be expected to produce cancerous or noncancerous adverse health effects, the combined effect of all these contaminants is also unlikely to be of public health concern.

4 Cancer Classifications

For the eight chemicals exceeding their respective CREG comparison values ATSDR provides the cancer classifications of NTP, IARC, EPA, and ACGIH in the following table. The differences between the classifications for individual substances reflects differences in the parent organization's definitions and methodologies.

Table E-1: Cancer Classifications for Air Chemicals

Chemical	NTP	IARC	EPA	ACGIH
Benzene	Known to be a carcinogen	1 - Carcinogenic to humans	A - Known human carcinogen	A1 - Confirmed human carcinogen
Methylene Chloride	Reasonably anticipated to be a carcinogen	2B - Possibly carcinogenic to humans	B2 - Probable human carcinogen	A3 - Confirmed animal carcinogen
PCE	Reasonably anticipated to be a carcinogen	2A - Probably carcinogenic to humans	Not available at this time	A3 - Confirmed animal carcinogen
TCE	Not listed by NTP[a]	2A - Probably carcinogenic to humans	Under review	A5 - Not suspected as a human carcinogen
Chloroform	Reasonably anticipated to be a carcinogen	2B - Possibly carcinogenic to humans	B2 - Probable human carcinogen	A3 - Confirmed animal carcinogen
Carbon Tetrachloride	Reasonably anticipated to be a carcinogen	2B - Possibly carcinogenic to humans	B2 - Probable human carcinogen	A3 - Confirmed animal carcinogen
Acrylonitrile	Reasonably anticipated to be a carcinogen	2B - Possibly carcinogenic to humans	B1 - Probable human carcinogen	A2 - Suspected human carcinogen
1,2-Dichloroethane	Reasonably anticipated to be a carcinogen	2B - Possibly carcinogenic to humans	B2 - Probable human carcinogen	A4 - Not classifiable as a human carcinogen

a If NTP approves committee recommendations, the 9th Report on Carcinogens will list TCE as "Reasonably Anticipated to be a Human Carcinogen".

EPA classifies a substance as a "probable" (B1 or B2) human carcinogen on the basis of what that agency considers to be "sufficient" evidence of carcinogenicity in animal studies and either "limited" (B1) or "inadequate" (B2) evidence in humans. EPA classifies a substance as a "possible" (C) human carcinogen if the animal evidence is "limited" and no human data are available.

IARC classifies a substance as a "probable" (2A) human carcinogen if the animal evidence is judged to be "sufficient" and the available human evidence is "limited." That agency classifies a substance as a "possible" (2B) human carcinogen if the animal evidence is less than sufficient and/or human data are "limited."

NT's classification of a substance as "reasonably anticipated to be a carcinogen" indicates only that under some set of exposure conditions the substance does cause cancer in one or more species of laboratory animal.

The ACGIH classification "suspected human carcinogen" (A2) is reserved for substances for which either the human data are accepted as adequate in quality but are conflicting or insufficient to classify the agent as a confirmed human carcinogen, or the agent is carcinogenic in experimental animals at dose(s), by route(s) of exposure, at site(s), of histological types(s), or by mechanism(s) considered relevant to worker exposure (ACGIH 1998).

The ACGIH classification "confirmed animal carcinogen" with unknown relevance to humans (A3) indicates that an agent is carcinogenic in experimental animals at a relatively high dose, by route(s) of administration, at site(s), of histological types(s), or by mechanism(s) that might not considered relevant to worker exposures. Additionally, ACGIH's A3 designation indicates that 1) available epidemiologic studies do not confirm an increased risk of cancer in exposed humans, and 2) available evidence suggests that the agent is not likely to cause cancer in humans except under uncommon or unlikely routes or levels of exposure (ACGIH 1998).

ACGIH designates as "not classifiable as a human carcinogen" (A4), agents which cause concern that they could be carcinogenic for humans but which because of a lack of data cannot be conclusively assessed. *In vitro* animal studies do not provide indications of carcinogenicity sufficient to classify the agent into one of the other categories (ACGIH 1998). ACGIH classifies as "not suspected as a human carcinogen" (A5) any agent which is not suspected to be a human carcinogen on the basis of properly controlled epidemiological studies in humans. These studies have sufficiently long follow up, reliable exposure histories, sufficiently high dose, and adequate statistical power to conclude that either exposure to the agent does not convey a significant risk of cancer to humans, or that the evidence suggesting a lack of carcinogenicity in experimental animals is supported by mechanistic data (ACGIH 1998).

References:

[ACGIH] American Conference of Governmental Industrial Hygienists. 1998. 1995-1996 threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1989. Toxicological profile for trichloroethylene. Atlanta: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997a. Toxicological profile for benzene (update). Atlanta: US Department of Health and Human Services.

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PUBLIC HEALTH ASSESSMENT

Air Addendum

AMOCO-SUGAR CREEK
(a/k/a AMOCO-SUGAR CREEK)
SUGAR CREEK, JACKSON COUNTY, MISSOURI

F. GLOSSARY OF TERMS

Absorption:
The process of taking in, as when a sponge takes up water. Chemicals may be absorbed through the skin into the bloodstream and then transported to other organs. Chemicals may also be absorbed into the bloodstream after breathing or swallowing.

Acute:
Occurring over a short time, usually a few minutes or hours. For purposes of health assessment, ATSDR defines acute exposures as those lasting up to two weeks. An acute exposure can result in short- or long-term health effects.

Ambient:
Surrounding. For example, *ambient* air is usually outdoor air (as opposed to indoor air).

Carcinogen:
Any substance that may produce cancer.

Chronic:
Occurring over a long period of time (more than 1 year).

Comparison Values:
Estimated contaminant concentrations in specific media that are not likely to cause adverse health effects, given a standard daily ingestion rate and standard body weight. The *comparison values* are calculated from the scientific literature available on exposure and health effects and usually include substantial margins of safety.

Concentration:
The amount of one substance dissolved or contained in a given amount of another. For example, sea water contains a higher concentration of salt than fresh water.

Contaminant:
Any substance or material that enters a system (e.g., the environment, human body, food, etc.) where it is not normally found.

Dermal:
Referring to the skin. *Dermal* absorption means absorption through the skin.

Dose:
The amount of substance that actually enters the body over a specified period of time. Dose is usually expressed in terms of unit weight of chemical per unit body weight per unit of time, e.g., mg/kg/day.

Epidemiology:
The study of the occurrence of disease in human populations and the factors associated with the frequency and distribution of that disease.

Exposure:
Contact with a chemical by swallowing, breathing, or direct contact (such as through the skin or eyes). *Exposure* may be short term (acute) or long term (chronic).

Hazard:
A possible source of danger or harm (that is, in this context, adverse health effects).

Health Outcome Data:
Information on the prevalence of death, disease or other health-related factors in the community. Such information may be derived from local, state, and national databases, medical records, tumor and disease registries, and health studies.

Indeterminate Public Health Hazard:
A formal conclusion category that ATSDR reserves for sites at which, due to the unavailability of critical information, no determination can be made regarding the existence or non-existence of a potential threat to health in the community.

Ingestion:
Swallowing (such as eating or drinking). Chemicals can get in or on food, drink, utensils, cigarettes, or hands, from which they can be ingested. After *ingestion*, chemicals that are absorbed into the blood are processed (metabolized) in the liver before being distributed throughout the body.

Inhalation:
Exposure to contaminants in the ambient air occurs principally via *inhalation*. If they are in gaseous form (as opposed to being adsorbed onto particles), inhaled contaminants can enter the general circulation directly, without being processed in the liver first, as are contaminants that are absorbed from the gastrointestinal tract.

Media (Environmental):
Soil, water, air, plants, animals, or any other parts of the environment that can contain contaminants.

Petitioned Public Health Assessment:

A public health assessment is conducted at the request of a member of the public. When a petition is received, a team of environmental and health scientists is assigned to gather information to ascertain, using standard public health criteria, whether there is a reasonable basis for conducting a public health assessment. Once ATSDR confirms that a public health assessment is needed, the *petitioned health assessment* process is essentially the same as the public health assessment process.

Public Health Action:

As used in ATSDR public health advisories, public health assessments, and health consultations, this term refers to activities designed to prevent exposures and/or to mitigate or prevent adverse health effects in populations living near hazardous waste sites or releases. These actions may include eliminating immediate exposures (e.g., by providing an alternative water supply), monitoring indicators of exposure in bodily fluids (e.g., blood and urine) to better assess exposure, and providing health education for health care providers and community members.

Public Health Hazard:

A formal conclusion category that ATSDR reserves for sites at which chronic, long-term exposure (>1 year) to potentially hazardous contaminants may cause illness in the community.

Route of Exposure:

The way in which a person may contact a chemical substance. The primary routes of exposure are ingestion (as in eating or drinking), inhalation (as in breathing), and dermal or skin contact (as in bathing).

Toxicological Profile:

An ATSDR reference document that identifies and reviews key, peer-reviewed literature describing the properties of a hazardous substances, the levels of significant exposure to that substance, and the associated acute, subacute (intermediate), and chronic health effects in laboratory animals and humans, where known. Toxicological Profiles also describe the experimental and/or epidemiological bases of ATSDR's existing comparison values for the substance, and identify knowledge gaps and research needs.

G. PUBLIC COMMENTS

The Agency for Toxic Substances and Disease Registry (ATSDR) released this Amoco Oil Company public health assessment air addendum for public review and comment from March 29, 2000, through June 30, 2000. Each comment received was logged and became part of the administrative record. This section contains both the comments received during the public comment period and ATSDR's responses to those comments. The comments have been numbered for convenience in referring to them. Following each comment is ATSDR's response to the comment.

Comment 1: The stated purpose of the May 1999 public health assessment is contrary to the public petition made to the ATSDR. The ATSDR has chosen to limit its study to determine "if current chronic indoor air exposures are of potential health concern for local residents." The petition made to the ATSDR did not limit the study to "current" health effects.

Response 1: In this public health assessment air addendum, ATSDR focused on known, site-specific, indoor

air exposures for which environmental data were available. No indoor air data for the Norledge area are available prior to June 1998. Our evaluation, therefore, was necessarily limited by the available environmental data to current, chronic health effects of indoor air exposures.

Of note, the May 1999 public health assessment is a separate document from this public health assessment air addendum. The May 1999 public health assessment was a public comment document released in final form on November 29, 2000. In the November 2000 public health assessment, ATSDR noted that residents are concerned about past air exposures from when the facility was operating. The agency also stated that groundwater data from the 1960s and 1970s, if available, could be used to model past indoor air concentrations. Since the release of the November 2000 public health assessment, however, EPA has been unable to locate any groundwater data collected at the site in the 1960s and 1970s (or earlier) that would be of use to ATSDR for modeling purposes (EPA 2002). If modeling had been feasible, the information it provided could have assisted in addressing community concern about past indoor air exposures.

> *Comment 2: By choosing to examine only "current" health effects, the ATSDR ignored past health effects caused by Amoco on the residents of Sugar Creek and Independence in the Amoco refinery area, thereby avoiding a potentially contentious dispute with BP Amoco and the expense of a comprehensive study.*

Response 2: As indicated in Response 1, ATSDR did not necessarily choose to limit our evaluation – it was limited by a lack of air data from when the facility was operating. The agency did, however, consider other options to address the residents' health concerns about past exposures. One of these options – modeling past indoor air concentrations – was not feasible. A second option targeted specifically at residents' concerns about multiple sclerosis (MS), was feasible. In fact, through the Jackson County Health Department ATSDR is funding a prevalence study to determine if higher rates of MS exist in Sugar Creek. Thirdly, to address concerns about cancer rates, ATSDR played an active role in reviewing the Missouri Department of Health's (MDOH's) cancer cluster investigations. Therefore, although ATSDR's public health assessments and health consultations focused on current and future exposure pathways, the agency supported other options to address past exposure concerns.

> *Comment 3: ATSDR's lack of a strong position on the subject of past exposures leaves the residents confused and uninformed about the impact of Amoco's past operations on their health. The ATSDR serves Amoco's purposes by avoiding the subject of past exposures, including cancer clusters which the Missouri Department of Health has indicated probably existed in the 1960's through 1970's.*

Response 3: Please see Responses 1 and 2. ATSDR's evaluations are limited by the type of environmental and health outcome data available.

MDOH investigated brain cancer, leukemia, and lymphoma. Their Level 2 inquiry showed mixed evidence for an incident brain cancer cluster and no evidence of a cluster of incident cases of leukemia or lymphoma (MDOH 2000). MDOH's Level 3 inquiry showed mixed evidence of a time and space clustering of brain cancer cases (MDOH 2000). The Level 4 inquiry determined it would not be feasible to undertake an etiologic study of environmental petrochemical exposure and primary brain cancer in Sugar Creek (MDOH 2001). However, MDOH will continue cancer surveillance in this area (MDOH 2001).

The results of an independent brain cancer cluster investigation found no statistically significant increase in the number of brain cancer cases in the community, although there are several limitations in this investigation (Neuberger et al 2003).

ATSDR is funding a MS prevalence study in the Sugar Creek area. Anecdotal information suggested a 2- to 4-fold elevation in MS prevalence above the expected national figures. The Jackson County Health Department entered into a cooperative agreement with ATSDR to address this issue. The research activity included the development of methods for case ascertainment and confirmation and the estimation of MS

prevalence for Sugar Creek (ATSDR 2003). A final report for this project is expected soon (ATSDR 2003).

Comment 4: The ATSDR has based its public health assessment, which provoked the air sampling, on incomplete data supplied by BP Amoco to the EPA and MDNR.

Response 4: ATSDR based its evaluations on air data that were available to the agency for review. The data reviewed are considered adequate for the purposes of our evaluation.

Comment 5: Figure 3, "Norledge Area Air Sampling Locations - 1999", is not accurate with respect to the location of several of the tested homes. Locations 1, 4, 5, 6 & 7 are not indicated correctly on Figure 3.

Response 5: Figure 3 provides the general locations of the homes where air sampling was conducted in 1999. ATSDR contacted the EPA to pinpoint further these locations. Modifications were incorporated into Figure 3.

Comment 6: The reference to CERCLIS No. should be changed throughout the text and figures to RCRIS No.

Response 6: ATSDR has deleted the designation "CERCLIS No." on all text and figures and replaced it with the designation "EPA Facility ID."

Comment 7: Section 2 indicates there are 100 residences in the Norledge area. This is incorrect as there are approximately 130 homes in the Norledge area.

Response 7: ATSDR modified the number of homes in Section 2.

Comment 8: In Section 2, paragraph 3, to clarify the type of samples collected, it is suggested that the text "(24 hour sample intervals)" be changed to "(24 hour composite samples)". It is also suggested that the second sentence in this paragraph be replaced with the following: Each home was sampled every other day for a period of one week. In July, three of these homes were re-sampled for an additional week.

Response 8: The suggested changes were made (see Section 2).

Comment 9: Section 3.1 is ambiguous in that it states only crude oil was spilt or leaked throughout the site. Free product like leaded gasoline and naphtha have been found in off-site monitoring wells. The fuel additive MTBE has been found in soil and groundwater off of Amoco's Refinery property.

Response 9: ATSDR updated Section 3.1 to state that leaded gasoline and naphtha were used on site. Amoco has been required to include the fuel additive methyl-tert-butyl ether (MTBE) in their sampling analyses even though Amoco maintains that MTBE was not used on site (EPA 2001b).

Comment 10: The report should clarify the location of Amoco's active pipelines. The active pipelines are located on the eastern portion of the site, well away from the study area. In addition, the active pipelines enter the site from off-site on the eastern and northern borders of the site.

Response 10: ATSDR modified Section 3.4.

Comment 11: Despite Amoco's stated policy of replacing underground pipelines in the 1970's, Amoco didn't institute that policy until the mid 1970's and never finished raising pipelines aboveground prior to closing the Refinery in March 1982.

Response 11: Starting in the 1970s Amoco began to replace underground pipelines with above-ground

pipelines to reduce the potential for undetected releases (TriTechnics Corporation 1995). The decommissioned underground lines were flushed with water in 1986-1987. A leaking pipe in a tank dike indicated, however, that some product remained in the lines after the flushing occurred. EPA requested that Amoco prepare a plan for investigating underground pipelines. As part of future investigations, Amoco will address underground piping and other subsurface structures (EPA 2001b). ATSDR modified the text in Section 3.4.

> *Comment 12: Since 1989, Amoco has successfully limited the reporting to the government agencies of Norledge area groundwater analysis to benzene, toluene, ethyl benzene and xylenes (BTEX). It has only been since 1999 that any environmental agency has required Amoco to test for a broader suite of constituents. When the government agencies did require Amoco to test for a broader suite of constituents, more were found. The testing is occurring too late to help the ATSDR to determine the health impact on Norledge area residents.*

Response 12: Although it might have varied due to sampling location, Amoco analyzed on-site samples for BTEX, polycyclic aromatic hydrocarbons (PAHs) and metals in soils, sludges and groundwater in the 1980s and 1990s (EPA 2002). Sampling in the 1980s and early 1990s, however, did not include sampling in the off-site Norledge area.

ATSDR did evaluate the site from the standpoint of its health impact on Norledge area residents. Specifically, we focused our evaluation on current and potential future exposures of Norledge area residents using available off-site data. The results of our evaluations are contained in a series of public health assessments and health consultations (see Section 10).

> *Comment 13: After nearly 12 years, the Amoco Refinery site still does not have an environmental agency approved RCRA RFI report.*

Response 13: Although responding to comments concerning the RFI are out of the purview of ATSDR's mission and of this public health assessment, ATSDR did contact EPA for clarification on this issue. EPA and MDNR are under joint signature to approve RFI documents (EPA 2001a). Since the 1995 RFI report was submitted, the EPA and MDNR have taken a different approach to completing the RFI process. Due to public concern, the agencies have focused most of the investigation in the off-site plume area and Amoco submitted an RFI report focused solely in this off-site area. This was done to expedite investigations and to implement cleanup activities in the off-site area. Subsequent investigations will be conducted in a phased manner for the remainder of the site (EPA 2001a). This information has been added to Section 3.4.

> *Comment 14: As of April 1998, the EPA and MDNR had over 120 comments and criticisms of Amoco's RFI, most of which have not been resolved. Since 1998 Amoco has implemented "remedial" measures with the dual purpose of enhancing its litigation position in lawsuits filed to force Amoco to clean up its off-site pollution and of avoiding environmental agency penalties.*

Response 14: Comments concerning the RFI for the Amoco site and the lawsuits filed against Amoco are outside the purview of ATSDR's mission (see Response 13).

> *Comment 15: The EPA and MDNR are aware that several of the laboratories used by Amoco for analysis of water and soil samples during the RFI investigation have been discredited and are under investigation for improper laboratory procedures. Amoco is aware of this faulty laboratory analysis and in 1998 informed the MDNR. The ATSDR's reliance on Amoco's faulty RFI investigation is a disservice to the people relying on the mission of the ATSDR to provide answers to their questions and concerns about how their health has impacted by Amoco's operations.*

Response 15: EPA reported that Intertek laboratory (also known as Inchscape and ITS) was indicted for falsifying data and quality assurance procedures. Intertek laboratory provided laboratory services for

hundreds of sites in Region 7 and many hundreds more nationally (EPA 2001a). In the case of Amoco, Intertek laboratory data was used in the 1995 RFI report and in quarterly reports for 1995 and 1996. Data from a second laboratory was also called into question because of the lack of quality assurance documentation. EPA reported that there is no indication that the data were not acceptable, but the laboratory in question had been under investigation for questionable laboratory practices during the time period in which the data were produced. Given this information it was decided that these data should be considered questionable. That said, however, EPA reported that this was a small amount of data that have not been used to make site decisions (EPA 2001a).

This public health assessment did not rely on any data from the 1995 RFI, as the focus was on air sampling reports from 1999. Of note, the November 2000 public health assessment did include a review of water and soil data. These data were compiled from a variety of sources and did not solely depend on the RFI data. As such, our conclusions in the November 2000 public health assessment remain unchanged.

> *Comment 16: Section 3.4 is incorrect when it states that Amoco installed the interceptor trench to control migration of hydrocarbons dissolved in groundwater. Amoco installed the trenches to collect and recover petroleum containing groundwater for reuse and re-refining to be added to its product stream.*

Response 16: According to the EPA, the interceptor trench served two purposes: 1) to recover free product, and 2) to control migration (EPA 2001a).

> *Comment 17: The first section of interceptor trench was installed in 1967, the second extension was installed in 1976, the third in 1983, the fourth in 1988 and the fifth & sixth sections in 1990. A gap was found between the 1967 and 1976 extensions and was finally closed in 1983. It wasn't until 1990 that the entire Burton Street area south of Norledge Avenue was "protected" by the interceptor trench.*

Response 17: Comment noted.

> *Comment 18: As of June 2000 the Norledge area bordered by Evans, Willow, Ash and Scarritt still does not have any interceptor trench or barrier wall to prevent hydrocarbon contaminated groundwater from migrating from the Refinery through the neighborhood.*

Response 18: ATSDR is aware no interceptor trench or barrier wall has been constructed in this area. Due to the possibility of volatization of chemicals from groundwater, indoor air sampling was conducted in homes in this specified area. These are the data evaluated in this public health assessment.

In addition to the interceptor trench, current interim measures in the Norledge area include enhanced fluid recovery (EFR) and total fluids extraction (TFE) (BP 2002). See Section 3.4 for further information.

> *Comment 19: Prior to 1998, Amoco only monitored the quality of the Norledge area groundwater. It didn't remove free product or any contaminated groundwater.*

Response 19: Starting in the 1960s, Amoco began to install an interceptor drain system and trenches to collect and recover petroleum in the groundwater (free product) for reuse and to prevent migration of hydrocarbons dissolved in the groundwater. The trench system affects the area south of Norledge Avenue. The interceptor trench was installed in several phases. See Section 3.4 which describes current interim measures occurring in the Norledge area.

> *Comment 20: Amoco collected hydrocarbon-contaminated groundwater at the Norledge Trench, but only after the benzene containing groundwater had passed and volatized under the majority of the residences in the Norledge area. Amoco has admitted its releases have been occurring since 1950. Many generations of Norledge area residents have been affected by Amoco's*

pollution.

Response 20: ATSDR agrees historical groundwater releases have been documented in the Norledge area. ATSDR's May 1999 public health assessment evaluated groundwater data, and recommended additional indoor air sampling in the Norledge area to determine if BTEX was volatizing from the groundwater into the air in Norledge area homes at levels of health concern. This public health assessment air addendum focuses on current indoor air exposures. Using the data reviewed by ATSDR, any benzene currently volatizing under Norledge area homes is not at levels of health concern.

Comment 21: We are glad that ATSDR raised the issue of the Norledge Trench. This system is nothing more than a French drain that leaks. We believe that the chemicals here are volatilizing, thus contributing to the ambient air contamination in the area. Until there is 24 hour, 7 days a week, 365 days a year ambient air monitoring, this will not be resolved. Testing ambient air occasionally will not give us a true picture of what is in the air.

Response 21: Outdoor (that is, ambient) air samples were collected and ATSDR evaluated these data in this public health assessment and in other ATSDR documents regarding the Norledge area. At the chemical levels detected, no adverse health effects would be expected for chronic exposure to outdoor air. Therefore, ATSDR does not recommend continuous monitoring of outdoor air.

Comment 22: We wonder why Section 3.4 discusses planned sampling activities on the part of EPA and Amoco.

Response 22: ATSDR believes it is important to provide the community with information about activities occurring in the Norledge area. The current interim measures will reduce the levels of contamination in groundwater and soil vapor.

Comment 23: You failed to include in your References section the three Amoco citations. These references should be added. It has come to our attention that these citations were Amoco Fact Sheets (a/k/a Amoco propaganda). If you are so willing to publish in your report, these Amoco Fact Sheets, you should also include information provided via the Citizens Investigation done by CLEANUP, who have provided substantial evidence relevant to your health assessment.

Response 23: The noted references were Amoco fact sheets. These fact sheets were not used for our public health evaluation – they were used as references to provide information about remediation and sampling activities Amoco planned. Section 3.4 has been updated to include current information, which is referenced accordingly.

During the public comment period for the May 1999 public health assessment a variety of entities including CLEANUP provided numerous additional environmental data sets to ATSDR. These data were reviewed in the final release of that document in November 2000.

Comment 24: The report should clarify that Amoco has completed the collection of additional soil vapor and air samples. The results will be included in the RFI Report to be submitted to MDNR and EPA.

Response 24: ATSDR received requests from Amoco, MDNR, and EPA to review additional air, soil, sediment, and surface water samples collected after this report was released. The results of our evaluations are contained in a series of health consultations (see Section 10). Overall, the data indicate no adverse health effects would be expected. At this time, ATSDR has not received any additional soil vapor sampling data.

Comment 25: Amoco is collecting 70 soil vapors from homes in the Norledge area. I'd request that the ATSDR receive, review and offer for public comment the results of Amoco's soil vapor investigation.

Response 25: Because soil gas measurements can only be evaluated to determine the extent to which contaminated groundwater might affect the air pathway, ATSDR prefers to review sampling data collected directly from the air pathway. ATSDR did, however, previously review RFI data on 35 soil gas samples collected primarily from the Norledge area in the November 2000 public health assessment. Because benzene, toluene, ethyl benzene and xylenes (BTEX) were detected in soil gas, ATSDR had recommended additional indoor air sampling. This public health assessment provides a review of the additional indoor air sampling results.

At this time, ATSDR has no plans to review additional soil vapor sampling data. Given current remedial measures in the Norledge area, including EFR and TFE, soil gas levels should be decreasing. Therefore, any potential contribution from the soil vapor media to indoor air levels should decrease as well.

> *Comment 26: In Section 3.5, the discussion concerning future responses to indoor air complaints should be revised to reflect the following: The preferred first responder to future indoor air complaints are the local police and fire departments. To assist them in their first responder role, the EPA has provided the Sugar Creek Fire Department a combustible gas indicator (CGI) and Photo Ionization Detector (PID). The equipment would be used to collect initial field screening information which EPA and MDNR would use to determine if additional response or sampling is necessary.*

Response 26: Section 3.5 has been modified accordingly. Furthermore, EPA recently transferred ownership of the CGI to the fire department and it is expected that PID ownership will also be transferred to the fire department in the near future (EPA 2002).

> *Comment 27: Section 3.5 is incorrect when it states that the MDNR and EPA have established procedures that "will enable those initially responding to odor complaints to take Summa canister air samples; that is, chemical specific samples, in Norledge area homes." As of April, 2000, the EPA and MDNR's preferred primary responder to the odor complaints was the City of Sugar Creek Fire Department. The EPA and MDNR loaned to the City of Sugar Creek Fire Department a MSA Model 260 combustible gas indicator and a Hnu Model PL 101 photo ionization detector. This loan is for only 18 months. Firefighter training on this equipment occurred on March 23, 2000. No Summa canisters or training have been provided to the City of Sugar Creek Fire Department. Please revise the Air Addendum to correctly reflect these facts.*

Response 27: This public health assessment addendum was updated accordingly (see Response 26 and Section 3.5).

> *Comment 28: Please note that the horizontal well system that is described has not been implemented according to Amoco's media announced time frame. The two horizontal wells installed in October were a "pilot test" and the EPA and MDNR's review of the results of the pilot test has not been completed. Amoco has installed none of the other horizontal wells it promised in the summer of 1999.*

Response 28: ATSDR is aware that the pilot test has taken longer than anticipated. This public health assessment was updated accordingly. See Section 3.4 for current information on the TFE horizontal well system.

> *Comment 29: The ATSDR's reliance on "default" conditions from the general population is flawed. The ATSDR has made no effort to determine (1) what the past Amoco site specific conditions were during and immediately after Amoco's closure of the Refinery's operations and (2) to what degree those Amoco site specific conditions were higher or lower than the general population "default" conditions. ATSDR's reliance on the environmental data is building a house on the sand.*

Response 29: As ATSDR uses the term, "default conditions of exposure" refers to the assumption that the average 70-kilogram (kg) adult consumes 2 liters of water and 100 milligrams (mg) of soil, and breathes about 20 liters of air, every day. For a 10-kg child, the corresponding defaults are 1 liter of water, 200 mg soil, and less than 10 liters of air, every day. These defaults are intentionally conservative overestimates. For example, few children actually consume more than 50 mg soil per day. ATSDR conservatism is enhanced when the defaults are used in site-specific exposure scenarios where it is typically assumed that all of the soil, water, or air that enters a person's body is contaminated with the highest detected site-specific concentration of the chemical of concern. In reality, the person's daily intake of any environmental medium comes from various sources that contain variable levels of contamination. Thus, dose estimates based on default conditions of exposure will generally exceed by a significant margin any dose estimates based on site-specific conditions of exposure. ATSDR's goal is to base public health decisions on dose estimates that are highly unlikely to underestimate the actual exposure of anyone associated with the site.

Comment 30: The report states in Section 4.1 that no other sources in the homes exist. Amoco representatives present during the testing observed the following potential sources of indoor air contaminants (especially benzene): cigarette smoking, natural gas usage, and paint/thinner storage. The report should be revised to include these as other potential sources in the homes. Also, the last sentence should refer to Tables 2 and 3.

Response 30: EPA staff conducting the sampling reported to ATSDR that each basement was inspected prior to sampling. None of the sources mentioned in this comment were reported. The tables are referenced in the second paragraph of Section 4.1.

Comment 31: The seven homes chosen for sampling by the EPA were based on the location of an underground plume identified exclusively by Amoco. The boundaries of this plume have never been defined; therefore, the number of persons who may be affected is unknown. We have documented visible signs of pollution north, south, east and west of these seven homes. We estimate that there are approximately 1000 households (if not more) in the affected area. Which means only 1 home in every 142 homes (less than 1% of the 1000 households) was sampled. This is outrageous and completely insufficient to determine any public health threat. At a minimum, quarterly sampling in 25% of area homes, for seven days (24 hour intervals) should have been part of the ATSDR's recommendation to regulators for the health assessment. Because chemical levels in indoor air are affected by weather, humidity, season, etc., quarterly sampling should be a given.

Response 31: The homes chosen were located above the known groundwater plume and are considered representative of indoor air in the Norledge area which encompasses approximately 130 homes. Changing seasons could affect the amount of groundwater contaminants volatilizing into the air in nearby residences. Considering this public health assessment and other ATSDR documents regarding the Norledge area, ATSDR evaluated indoor air data from both warm and cold months. The range of concentrations within the homes appears consistent.

Comment 32: In Section 4.1, you note that EPA took nine outdoor samples from five of the homes sampled. These were considered background samples. This is absurd. Background samples must be taken in an area that is not contaminated by toxic chemicals. With the background samples being already contaminated due to their location, the other test data is highly questionable, thus causing the indoor air samples to look less health threatening. In lay terms, if the background air already shows chemical levels, instead of subtracting that level, it should be added to indoor level to show what is in the air.

Response 32: ATSDR stated that these samples were considered background by EPA, not by ATSDR. To avoid confusion, the statement was removed from the public health assessment. Of note, ATSDR evaluates exposure to the maximum value detected, regardless of whether it is considered background by another agency. ATSDR's goal is to base public health decisions on dose estimates that are highly unlikely to

underestimate the actual exposure of anyone associated with the site (see Response 29).

> *Comment 33: In Section 4.1, it would help to identify those chemicals that exceeded the health-based comparison values for both indoor and outdoor samples. This would help to show the limited impact of contaminant migration from the soil to indoor air.*

Response 33: ATSDR modified this section to specify which chemicals exceeded comparison values in indoor samples and which chemicals exceeded comparison values in outdoor samples.

> *Comment 34: The report needs to state more clearly that although many chemicals were detected in the homes, most of these are not constituents of the groundwater contamination. The report could potentially mislead the reader into believing that all chemicals detected in the homes are potentially from former refinery operations. Many of the detected compounds in indoor air (e.g., chloroform, methylene chloride, tetrachloroethylene, trichloroethylene, carbon tetrachloride, 1,2-dichloroethane) have not been detected in the groundwater below the neighborhood. Most of these compounds are unlikely to be associated with petroleum hydrocarbons found in refinery processes, and are probably related to other indoor air sources.*

Response 34: ATSDR's public health conclusions are determined by the magnitude and by the duration of exposures to specific chemicals, rather than by the source of those exposures. Nevertheless, the chemicals mentioned in this comment were not detected in groundwater, thus appropriate qualifying statements were added to this public health assessment (see Section 5, paragraph 2).

> *Comment 35: Section 4.2 indicates that representatives of the EPA, Amoco and ATSDR are attempting to determine if anything on-site could have triggered these releases. Due to a resident's investigation, an EPA representative visited on-site refinery tank berms, upgradient of a home, and found pipes containing hydrocarbons and stained soil. Amoco stated to the EPA and MDNR that these pipes were flushed and cleaned in the late 1980s and yet, in November 1999, hydrocarbon product is still present in the leaking underground pipelines.*

Response 35: Access to this area is restricted. The EPA and MDNR visited this area and found exposed pipes which had obviously leaked. Amoco responded by excavating the pipes to determine where they go, flushing out the pipes, and capping them. The contaminated soil has also been removed. See Response 11 and Section 3.4 for additional information.

> *Comment 36: Section 5 is flawed in its entirety because it is based on limited air testing in current conditions. Section 5 fails to provide any satisfaction to residents concerned about the long term and chronic impact of Amoco's operations on their health.*

Response 36: Section 5 and Appendix E address the issue of whether current exposure levels will impact the residents' health today and in the future. Using the data reviewed in this document, the November 2000 public health assessment, and several air health consultations, ATSDR concluded that current chemical levels are not likely to cause adverse health effects.

Of note, ATSDR reviewed several options to address concerns about the effect of past exposures on residents' health. Please refer to the agency's responses to Comments 1, 2 and 3 for further information.

> *Comment 37: ATSDR notes the very phenomenon that has plagued the residents: Odors here today, gone the next.*

Response 37: ATSDR sympathizes with the residents who have been plagued by odors. Any environmental data provided to ATSDR for review from odor response reports will be evaluated and provided to the community.

Comment 38: In Section 5, paragraph 4, you note that you are merely "estimating" levels of benzene (using median value). Unacceptable. If there was a consistent, chemical-specific air monitoring plan in place, you would not have to do this. What of the people breathing in high levels every other day or week?

Response 38: ATSDR provided a detailed evaluation of site-specific benzene exposures in Appendix E. The paragraph in Section 5 of the main text is a summary of the two pages of detailed benzene text found in Appendix E. Exposures to the maximum air levels of benzene, along with other chemicals, were evaluated assuming people in the Norledge area were chronically breathing the maximum level. No adverse health effects would be expected at these levels.

Comment 39: In Section 5, paragraph 5, the first sentence should be revised to read as follows "The CREGs for chloroform, methylene chloride, tetrachloroethylene, and trichloroethylene are not derived from human exposure data, but rather are all based primarily on mouse liver tumors and male kidney tumors produced by species specific mechanisms that are evidently dependent on unusually high doses."

Response 39: ATSDR modified the sentence.

Comment 40: We are still dissatisfied with the limited list of contaminants in question, since each time a new set of tests are conducted, it changes the entire overview such as modeling for example. You note in Section 5 that "the October 1999 chemical-specific air data are included in this evaluation because ATSDR considers the data representative of chronic exposure levels (that is, the reported odors had dissipated before chemical-specific testing was conducted)" and that "The primary focus is on those contaminants that were present at levels in excess of one or more health-based comparison levels." This makes no sense. How can this be representative AT ALL? You should be recommending more indoor and ambient air sampling that IS chemical specific to be sure! The minimum of test homes should never be less than 25% of the affected area.

Response 40: The homes chosen were located above the known groundwater plume and are considered representative of indoor air in the Norledge area, which encompasses approximately 130 homes. Considering this public health assessment and other ATSDR documents regarding the Norledge area, ATSDR evaluated numerous sets of chemical-specific air data. The range of concentrations within the homes appears consistent. No adverse health effects would be expected at the detected levels of chemicals.

Comment 41: What about the chemicals that do not cause an odor therefore are not as noticeable to be concerned about? For example: A person has a headache, but there are no noticeable odors, yet when the air is tested contaminants are discovered. The people have not made note of what they cannot smell, perhaps putting themselves in jeopardy.

Response 41: Headaches are non-specific symptoms of numerous health conditions, most of which are not related with exposure to airborne contaminants. And there is no correlation between a chemical's odor threshold and its threshold of toxicity. Some compounds have odor thresholds generally lower than their toxicity thresholds – such substances are said to have "warning odors" – while others do not. The odor threshold of benzene, for example, is around 4.9 mg/m^3 or about 1.5 ppm which is lower than levels known to cause adverse health effects in animals or humans and exceeds the highest level detected in Sugar Creek homes by an order of magnitude.

Comment 42: The literature on which you base your assessment is both misleading and often irrelevant to the Sugar Creek investigation. Worker exposures (typically, young, male, 40 hours per week, high level exposure, protective gear) differ substantially from chronic residential exposures (women, children, elderly of all ages which are likely to unknowingly receive both low and high level exposures from multiple exposure pathways) for many more hours a day.

Response 42: ATSDR takes great care not to mislead its readers. If some of the literature cited in ATSDR's assessment for Sugar Creek appears not to be directly relevant to the investigation, it could be because such material (like historical occupational data) is introduced to put site-specific exposures into a more meaningful perspective. Even though a 24-hour day is 3 times longer than a typical 8-hour work day, historical occupational exposures are often 10-1000 times higher than current exposures in the general population. This sizeable difference in daily exposures makes historical occupational exposures particularly useful for purposes of comparison. Assume, for example, that no adverse health effects had ever been seen in workers exposed for a working lifetime to average levels of a substance more than 10 times the maximum level of the same substance detected off-site in the general population. Under such assumptions there would be little reason to expect adverse health effects to occur in response to non-occupational exposures, even if they did occur for 24 hrs/day. As useful as they are, however, such comparisons are used for illustrative purposes and do not constitute the sole basis of ATSDR's conclusions. The latter are based on the best medical and toxicological data available and are designed to be conservatively protective of public health, including susceptible populations like the elderly and young children.

> *Comment 43: The research you have cited regarding animals is irrelevant to research done on human animals. You make this point yourself in Section 5 when you argue: "the CREGs for chloroform, methylene chloride, tetrachloroethylene, and trichloroethylene have limited relevance to humans because all are based primarily on mouse liver tumors and male rat kidney tumors produced by species-specific mechanisms that are evidently dependent on unusually high doses." However, you contradict yourself three paragraphs later when you argue: "In a recent inhalation study (ATSDR 1994), no increased carcinogenic effects were seen in rats chronically exposed for 2 years, therefore, indoor air exposures to the levels of 1,2 -dichloroethane detected in the Norledge area would not be expected to result in adverse health effects." You cannot extrapolate "data" from animals to human animals. This makes no sense! Animals and humans are radically different (for example, biologically, immunologically, histiologically, etc.) and animals are subjected to ridiculously high doses of toxic chemicals in high stress situations. Unacceptable.*

Response 43: It is well known that the results of animal assays are not accurately predictive of human health effects. Animal data have numerous limitations in this regard and must therefore be interpreted very carefully by anyone using them to estimate the potential implications of chemical exposures in humans. For this reason, ATSDR emphasizes species differences and aspects of animal study protocols (for example, the use of unrealistically high doses) that differ markedly from human exposure conditions. While human data are obviously preferable to animal data, the former are often unavailable – there is no choice but to use animal data as an admittedly imperfect surrogate. But even when epidemiological information is available it is fraught with problems of its own. For example, in human studies the exposure is never as well defined, in terms of number, magnitude, and duration of exposures, as it is in animal studies. Therefore, whether human data are available, a critical evaluation of the animal data is an important part of ATSDR's overall assessment. The relevance of the animal data to the human condition is always carefully evaluated for each chemical and the appropriately conservative assumptions and safety factors are introduced to assure that any conclusions drawn will be protective of public health. All assumptions, safety factors, and other caveats are called to the readers' attention in the text of the health assessment.

> *Comment 44: As we have stated in previous comments regarding other ATSDR and MDOH health reports, we are concerned that there is no consideration of the interactive and/or cumulative effects of toxic chemicals. Note: we do not buy the argument you give in Section 5: "the combined effect of all these contaminants is not likely to be of public health concern based on studies which suggest that a mixture produces no adverse health effects in dosed animals."*

Response 44: Additional supporting toxicological information is provided in Appendix E (see Appendix E, Section 3).

Comment 45: Paragraph 9 of Section 5 illogically concludes that "(S)ince the individual contaminants detected in indoor air at this site have consistently been present below levels that might be expected to result in adverse health effects, ATSDR considers that the combined effect of all these contaminants is not likely to be of public health concern." The ATSDR does not have the breadth of data, the historical knowledge of the past residential exposures, or the complete knowledge of Amoco's past operations to conclude that the contaminants detected in the indoor air have consistently been below levels expected to cause adverse health effects. The ATSDR should remove this inaccurate statement from the Air Addendum.

Response 45: ATSDR has amended the statement to include the time-frame of evaluation. Specifically, the sentence now states "Because the individual contaminants detected currently in indoor air at this site have consistently been present below levels that might be expected to result in adverse health effects, ATSDR considers that current exposures to the combined effect of all these contaminants is not likely to be of public health concern."

Comment 46: Please advise why the EPA didn't respond to the October 14, 1999, odor complaint with the proper equipment to sample and quantify the constituents of the odor. If the EPA had responded with proper equipment, then the ATSDR could have given its opinion on the health implications of the odors.

Response 46: EPA reported that because the odor complaint dealt with an indoor air quality issue, the EPA response team was equipped with and used the appropriate monitoring equipment (PID and draeger tubes) to assess the scene (EPA 2002).

Comment 47: Approximately 8 pages were dedicated to the October 1999 odor event. We are outraged by your accusations that imply the event and the odors were rigged. First, for the record, this is what happened. One of the homeowners and an associate returned from a walk to find the home filled with petroleum-like odors. The other homeowner, who had been in the home for some time, was totally unaware that the odor was present. In fact he argued that he could not smell it. The homeowners associate was able, through some difficulty, to reach a member of the ATSDR and Bob Aston (EPA Region VII). At that point, we realized that there was no entity prepared to respond to an emergency such as this. Several hours passed before the EPA Emergency Response team arrived. These people were not dressed in any kind of safety gear. We can only assume that the odor report was not taken seriously. The fact that they did not show up with the proper equipment, further supports our suspicions. Once in the home, however, both members of the team confirmed that they too smelled petroleum-like odors. Testing commenced.

Response 47: ATSDR did not mean to imply the odor event was rigged. In fact ATSDR agrees with the community that accurately capturing the chemicals related to odor events is difficult due to the very nature of the odor events. All those involved with the odor event took it seriously. Although ATSDR was not present during the October 1999 odor event, Atlanta-based staff spoke to those individuals who were involved with the odor event in an attempt to piece together what occurred. ATSDR apologizes for any inconsistencies in our report of the event. ATSDR did, however, document each telephone call and cannot change what was reported to us at that time by the individuals in question.

The EPA response team was composed of personnel from the Superfund Emergency Response and Removal Branch. As stated previously, the EPA response team was equipped with and used the appropriate monitoring equipment. The complaint did not deal with a spill type of situation which would have involved potential dermal exposures and would have required additional health and safety considerations (EPA 2002).

Comment 48: Despite the resident evidently committing the apparently horrendous offense of leaving the "cleanout line" open, the ATSDR, in its own explanation of the purpose for the cleanout line, appears to overlook the fact that the air from the sewer which migrated via the cleanout line contained benzene, chloroform, methylene chloride, tetrachloroethylene and

trichloroethylene in exceedance of health-based comparison values.

Response 48: In Section 5 and Appendix E, ATSDR assumed residents would be chronically exposed to the maximum levels detected of these chemicals (whether the maximum value was from the cleanout line, or the basement indoor air, or the outdoor air) for our evaluation. At the maximum levels detected, no adverse health effects would be expected based on chronic exposure.

Comment 49: With respect to the open cleanout line, it has a chained, bathtub-type plug, white in color, attached. The homeowner had been doing laundry that day of the odor event and as was customary, she removed the bathtub-type plug from the line so that the excess water could drain. Often, if the plug is not removed, the drain would overflow into the basement. Sometimes, the homeowner forgets to put the plug back in. You said that no cap or plug was in sight when EPA arrived. It was there, as it is attached by the chain to the pipe. There were different times where the homeowners were told to leave the plug in or take it out, so there is nothing sinister in that. The point is in this situation that, there were odors then and odors have been detected since then, so they do come and go which is a perfect reason why sampling of any homes should be done regularly rather than once in awhile.

Response 49: ATSDR sympathizes with the residents who have been plagued by odors. Any environmental data provided to ATSDR for review from odor response reports will be evaluated and provided to the community.

As stated in Response 47, ATSDR apologizes for any inconsistencies in our report of the event. ATSDR did, however, document each telephone call. One person reported to ATSDR that no cap or plug was in sight; however, because the plug is chained to a pipe, the agency has deleted reference to "no cap or plug was in sight' from Section 4.2.

Of concern, the "plug" should not be removed for any reason other than plumbing maintenance. Sewer gases will escape into the basement with the plug removed. To avoid this problem homeowners who regularly have drain overflows when doing laundry should contact a professional plumber to ensure the washing machine is properly connected.

Comment 50: Never at any time did we smell sewer gas during the odor event, and even Amoco tests show no H_2S. A petroleum odor does not smell like sewer gas. If ATSDR had come out that night they would have smelled it and not accused us of rigging the test results. Your report is a public document, therefore, the public would conclude that the homeowners and their associate somehow faked the odors to cause the event. Clarification of what really happened should be made publicly.

Response 50: ATSDR does not believe the odors were faked. As stated previously, ATSDR apologizes for any inconsistencies in our report of the event. ATSDR did, however, document each telephone call and the agency cannot change what was reported to us at that time by the individuals in question.

Comment 51: To us it is ironic that so much time was devoted to the famous PLUG (mentioned eight times out of ten pages of an eighteen page report) when the kinds of chemicals discovered should have been much more important.

Response 51: ATSDR provides an evaluation of exposure to air chemicals in Section 5 and Appendix E.

Comment 52: The situation (odor event) was very confusing because there was an expression of the need to evacuate by authorities, then by the time it was safer, the homeowners returned. The odors are not new either. People in Sugar Creek think they have to live with the smell, never realizing it may be hurting their health. The lack of concern and attitude that people are liars when they call in air complaints have deterred others from reporting new ones. Very recently,

the city told an individual that the odors were coming from New Mexico when the person called to make a complaint. Although the mayor has apologized (privately) for this incident, how many other times have people been treated like that?

Response 52: ATSDR sympathizes with the residents who have been plagued by odors. ATSDR encourages individuals continue to report odor events. However, as stated in Response 41, the presence of a detectable odor does not, by itself, constitute evidence that conditions are unsafe and warrant evacuation.

Comment 53: The drain at the homeowner's home comes from the Burton street sewer line which has been verified to be seriously contaminated. Two other homes had odors but aired their basement and ignored it. It is important that an investigation of the sewers be conducted, but we have heard nothing about that. The sewers are a likely source of pollution pathways as your report indicates. We believe the sewer system on the refinery is a major concern also, but EPA and MDNR seem disinterested in that source. We would like to remind you that an EPA contractor (Tetra Tech EM Inc. September 18, 1997), made strong recommendations to EPA about RBCs, exposure pathways via sewer systems, plume definitions, etc. and we would like those comments to be included with our comments for ATSDR's consideration, since we believe the same basis for comment applies now.

Response 53: As stated in this public health assessment, the sewer system was investigated as a potential source of the reported odors. The investigation failed conclusively to identify soil gas, contaminated groundwater, or the sewers as a probable source of the odors reported in this home on October 14, 1999.

Comment 54: With regard to Comment 1 of Section 6, please note that methane is a byproduct of natural attenuation of hydrocarbons. In fact, levels of methane and other VOCs were so high in the isolated plumes near the City of Sugar Creek Fire Station that Amoco proposed fueling a V-6 engine from the fumes on the plume.

Response 54: Amoco originally wanted to test the ability of vapors recovered from the EFR system to be used as a partial source of fuel for an internal combustion engine. Initial tests revealed that the recovered vapors would not sustain the fuel requirements of an internal combustion engine without substantial amounts of primary fuel (gasoline). This vapor treatment alternative was never implemented (EPA 2001b).

Comment 55: With regard to Comment 4, will the ATSDR revise its report when additional contaminants are found off-site, for example, like the MTBE which was recently found on and off-site by environmental agencies? This points out again the limited and flawed testing that Amoco has done over the last 12 years and the flawed reliance on the data by the ATSDR and environmental agencies.

Response 55: ATSDR will revise its report if additional data are found that indicate conclusions that are not consistent with what has been previously determined.

Comment 56: As early as 1986 and 1989, the City of Sugar Creek noted staining and deposits of hydrocarbons in the sewer lines. This information is in the possession of the City of Sugar Creek and has been offered to the US EPA.

Response 56: Comment noted.

Comment 57: Please advise when the ATSDR will evaluate the public health significance of the reported odors that residents e-mail to the government agencies on a daily basis.

Response 57: ATSDR is maintaining a file of the odors reported to our regional office; however, the agency suggests the residents contact the fire department to report the odors. If requested, ATSDR will evaluate environmental air sampling data that are collected in response to the odor complaints.

Comment 58: Please advise how the ATSDR can find chemicals, including benzene, during June 1999 sampling that exceed health-based comparison values and yet, still opine that the current, chronic exposures to indoor air pose No Apparent Public Health Hazard.

Response 58: As stated in this public health assessment, health-based comparison values are not thresholds of toxicity. Although concentrations at or below the relevant comparison values could reasonably be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. The fact that a contaminant exceeds a health-based comparison value does not necessarily imply the existence of a public health hazard. Comparison values are used only to identify those site-specific contaminants that warrant further investigation. The health implications – if any – of exposures can only be determined in the context of the best medical and toxicological information available (see Section 5, Appendix C, and Appendix D). After a review of the data, ATSDR determined that current, chronic exposures to indoor air in the Norledge area are not at levels of health concern.

Comment 59: By proclaiming there is No Apparent Public Health Hazard, the ATSDR appears to want to ignore that the health-based comparison values found in the year 2000 would not be reflective of the values that could have been found (if the EPA and MDNR had required Amoco to test for them) in the 1950s, 1960s, 1970s, 1980s or early to mid 1990s.

Response 59: This focus of this PHA was to determine whether current, chronic exposures to indoor air in the Norledge area are at levels of health concern. ATSDR determined that current, chronic exposures to the contaminant levels detected are not likely to be associated with adverse heath effects. ATSDR cannot evaluate the public health implications of chemicals that might have been present from 1950 to mid-1990 because environmental data are not available.

Comment 60: The ATSDR concludes that due to remedial activities in the Norledge area, contaminant concentrations will decrease as well. This opinion parallels Amoco's conclusion drawn in the early 1980's when faced with the magnitude and expense of cleaning up the off-site hydrocarbon contamination. Amoco's "do nothing, it'll go away" attitude has saved it millions of dollars in remediation costs.

Response 60: ATSDR is unable to comment on Amoco's conclusions; however, current and planned remedial activities in the Norledge area should result in decreasing contaminant concentrations. In October 2002, EPA reported that since the initiation of the EFR system, levels of contamination have decreased (EPA 2002). See Section 3.4 for additional information.

Comment 61: We disagree that "groundwater and subsurface soil remedial activities in the Norledge area should result in decreasing contaminant concentrations in the future" and believe that your responsibility to assess public health risk is NOW, not in some distant future.

Response 61: ATSDR did evaluate the current public health risk and determined that air chemicals are not at levels of health concern for chronic exposure. Concentrations of groundwater contaminants will decrease in the future because of remedial activities. EFR has been successful in assisting in the natural attenuation of VOC concentrations in groundwater; benzene concentrations have been decreasing (BP 2003). And, approximately 87,300 pounds of hydrocarbon were removed by TFE (BP 2003). ATSDR states that any future exposures possibly related to chemicals that could volatilize into homes in the Norledge area should decrease as the groundwater contamination decreases.

Comment 62: The lack of recommendations on the part of the ATSDR is not only irresponsible, it is unconscionable. You should have, at the very least, recommended more air monitoring. Ideally, this would be 24 hours a day, 7 days a week, 365 days a year, both ambient and indoor. It is not unheard of.

Response 62: The purpose of this public health assessment was to review air sampling data reports to determine whether current chronic air exposures were of potential health concern for local residents. ATSDR determined the chemicals detected in air were not at levels of health concern; therefore, additional sampling was not recommended at this time. The agency is available to review additional air sampling data collected from the Norledge area, upon request.

> *Comment 63: In Section 10, the last sentence of the text should be revised to reflect that residential surface samples have been collected by EPA, and ATSDR is preparing a health consultation on this data.*

Response 63: Section 10, Public Health Action Plan, has been updated to include activities ATSDR accomplished since public comment release of this document.

> *Comment 64: In Appendix E, the ATSDR's reliance on the research of Dr. Otto Wong is ironic. Amoco hired Dr. Wong to testify on Amoco's behalf during the United States District Court Class Action. Dr. Wong's deposition was taken in that case in direct opposition to the interests of the residents of Sugar Creek and Independence, Missouri.*

Response 64: Together with numerous other scientists Dr. Wong was cited in the agency's public health assessment because his work in the field was both highly relevant and scientifically valid.

> *Comment 65: We totally disagree with the almost exclusive focus on benzene. As we have noted before, the list of contaminants should be expanded. Independent testing has supported our opinion, as well as MDNR/EPA tests taken at areas we discovered and complained about. For example, MTBE has been found in both soil and groundwater in the residential areas, and Amoco denies ever having that chemical onsite.*

Response 65: ATSDR agrees that a broad range of contaminants should be included in analyses of environmental media at the site. The focus of this public health assessment is to evaluate exposure to contaminants possibly volatilizing from groundwater into the air in Norledge area residences. Numerous potentially volatile contaminants were analyzed for in samples collected in homes in the Norledge area – none of those contaminants were detected at levels of health concern.

> *Comment 66: Again, we are requesting a public health meeting of a different format than you have provided in the past. We want a meeting, with the opportunity for the public to ask questions, NOT a few measly information tables. The public has a right to this type of forum.*

Response 66: When ATSDR released the first public health assessment for public comment back in May 1999, the agency did hold a large public meeting. During this evening meeting, agency staff presented the findings of the document to the Sugar Creek community as well as answered many questions from the community. Earlier that same day, the agency held public availability sessions which allowed the agency to hear concerns and answer questions from Sugar Creek residents on an individual, one-on-one, basis.

> *Comment 67: LIMITATIONS? You do not discuss them in this report. Without knowing what the limitations are, we cannot comment, and they should be included to have a balanced study.*

Response 67: As stated in Section 2, Purpose and Health Issues, this public health assessment is limited to an evaluation of indoor and outdoor air samples collected by the EPA in June, July and October 1999. The evaluation focused on a review of these sampling data reports to determine if current chronic air exposures were of potential health concern for local residents. Although other environmental media and exposure pathways are not addressed in this public health assessment, a summary of the results of ATSDR's other evaluations are contained in Section 10.

> *Comment 68: In November 26, 1997, Randall D. Maley, M.P.H., MDOH wrote Mr. Rob*

Morrison of the MDNR after they reviewed Amoco's Addendum to their Workplan. We want that document included with our comments since it makes suggestions that were likely ignored by MDNR.

Response 68: Responding to comments on another agency's workplan is out of the purview of this public health assessment. ATSDR suggests MDNR and MDOH be contacted directly to find out what comments were incorporated into the workplan.

Comment 69: According to Denise Joran-Izaguirre ATSDR Regional Representative, this report never passed her desk, otherwise she would have corrected all the errors. We cannot imagine a public health threat being handled so irresponsibly.

Response 69: ATSDR Regional Representative Denise Jordan-Izaguirre did review this health assessment before its release to the public. ATSDR based the report on data and information available to the agency at that time. One of the primary reasons for a public comment period is to ensure the agency's reports are accurate and address all pertinent issues. Appropriate changes are made to the public comment version before the document is released in final form.

References

[ATSDR] Agency for Toxic Substances and Disease Registry. 2003. March 3 fact sheet: multiple sclerosis and amyotrophic lateral sclerosis-related projects. Atlanta: US Department of Health and Human Services.

[BP] BP Products of North America, Inc. 2003. Annual interim measures performance monitoring summary, 2002, BP Products North America, Inc., (a former Amoco Oil Company) regarding the former refinery at Sugar Creek, MO. Golden, CO: The RETEC Group, Inc; project number AMO61-16275-780.

[EPA] Environmental Protection Agency. 2001a. March 12 electronic mail record with attachment (ATSDRQand A.wpd) sent by Robert Aston, EPA, to Denise Jordan-Izaguirre, ATSDR, containing EPA's responses to a list of questions ATSDR submitted about activities in the Norledge area of Sugar Creek. Kansas City, Kansas.

[EPA] Environmental Protection Agency. 2001b. March 12 electronic mail record with attachment (ATSDRQandA2.wpd) sent by Robert Aston, EPA, to Denise Jordan-Izaguirre, ATSDR, containing EPA's responses to a second list of questions ATSDR submitted about activities in the Norledge area of Sugar Creek. Kansas City, Kansas.

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[MDOH] Missouri Department of Health. 2001. Assessment of the feasibility of an etiologic study of the association of brain cancer and environmental petrochemical exposure. Jefferson City, Missouri.

Neuberger JS, Ward-Smith P, Morantz RA, Tian C, Schmelzle KH, Mayo MS et al. 2003. Brain cancer in a residential area bordering on an oil refinery. Neuroepidemiol 22:46-56.

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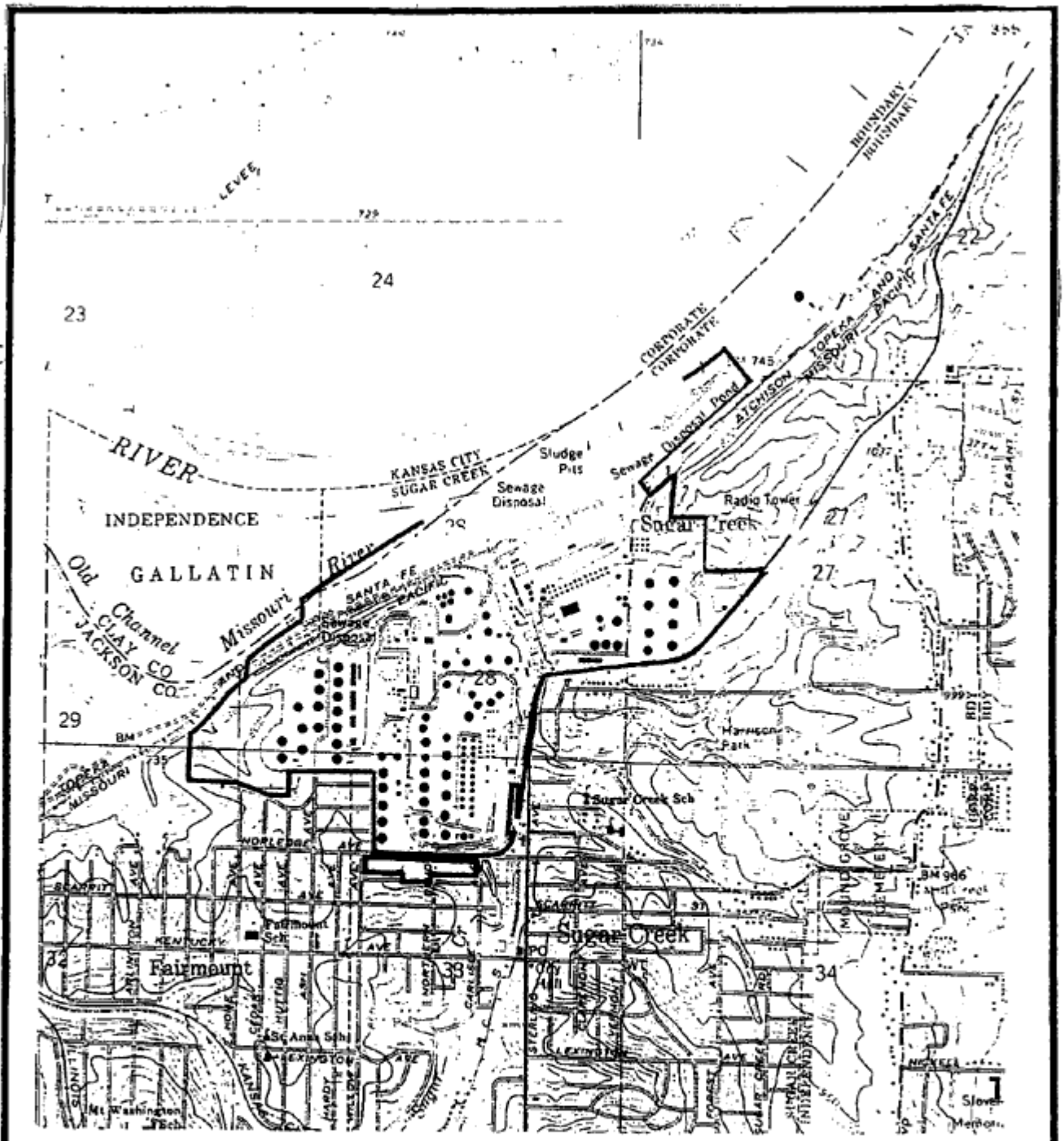
Figure 1: Amoco Oil Company Site Location Map, Sugar Creek, Missouri



Reference: Independence & Liberty Quadrangle Maps. USGS 1975

Contour Interval = 10 ft.

TriTechnics CORPORATION
Air, Water and Soil Management

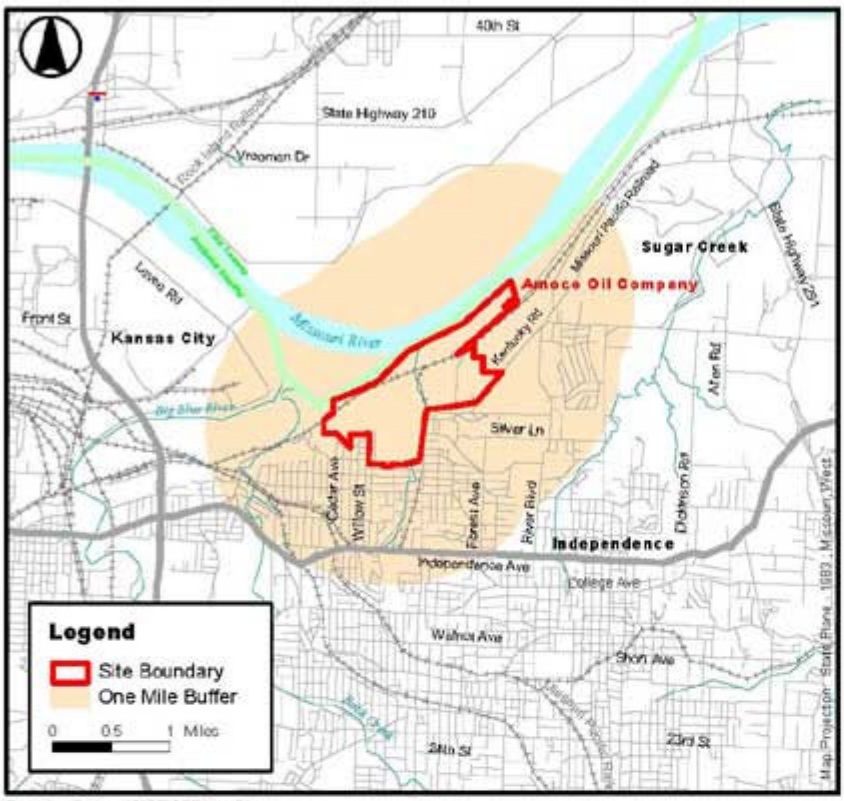
Source: Figure adapted from TriTechnics Corporation, 1995.

Checked By:
Drawn By: ESS
Date: 9/20/95
File Name: 004RR33

Amoco Oil Company

Sugar Creek, Missouri

INTRO MAP

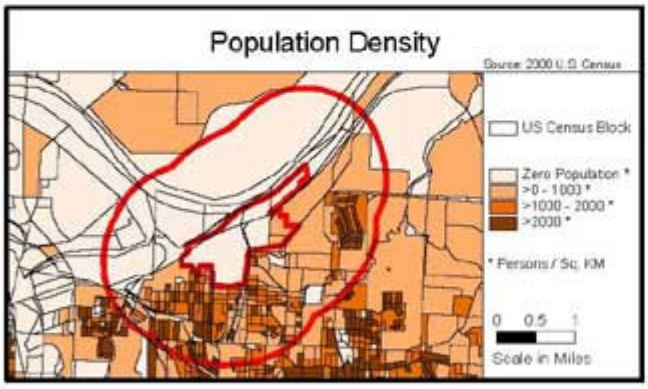


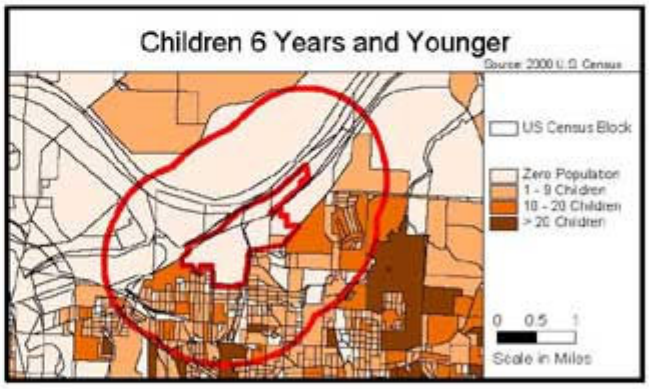
Base Map Source: 1995 TIGER/Line Files

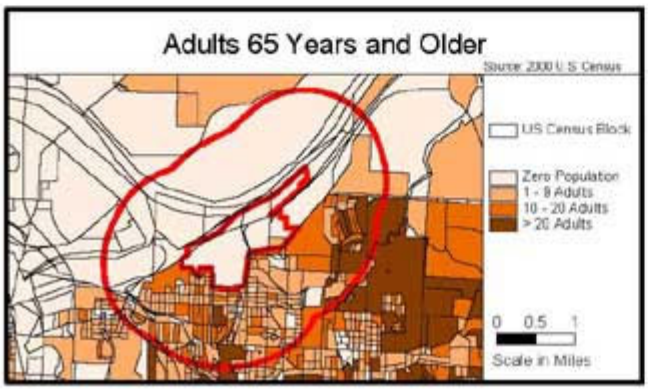
Jackson County, Missouri

Demographic Statistics Within Area of Concern*	
Total Population	9708
White alone	8952
Black alone	137
Am. Indian and Alaska Native alone	68
Asian alone	62
Native Hawaiian and Other Pacific Islander alone	96
Some other race alone	159
Two or More races	238
Hispanic or Latino	383
Children Aged 6 and Younger	927
Adults Aged 65 and Older	1393
Females Aged 15 - 44	1933
Total Housing Units	4446

Demographics Statistics Source: 2000 US Census
*Calculated using an area-proportion spatial analysis technique







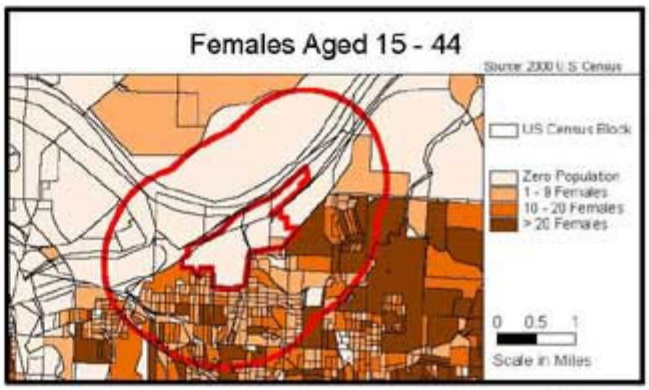


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Figure 3: Norledge Area Air Sampling Locations - 1999

Amoco Oil Company

EPA Facility ID MOD007161425